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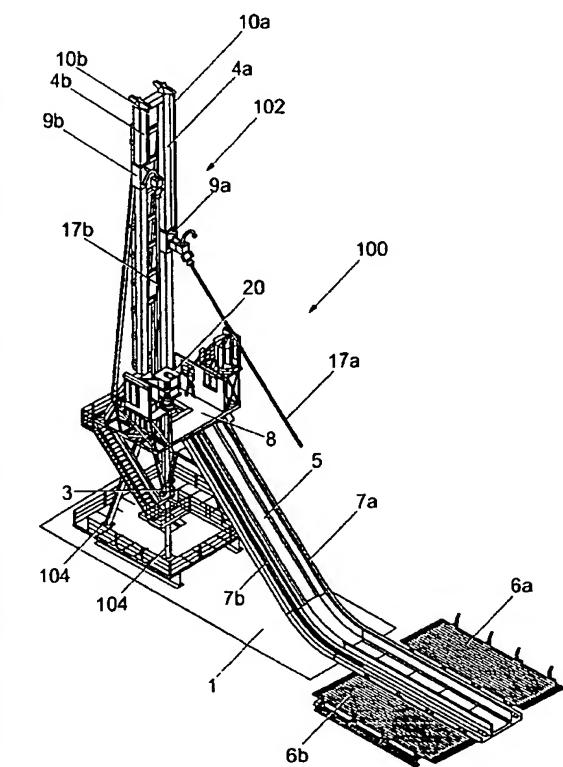
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(54) Title: APPARATUS AND METHOD



(57) Abstract: A tong system includes an upper tong having grips for gripping a tubular and a rotation mechanism to rotate the grips and the tubular. A lower tong also has grips and a rotation mechanism to rotate the grips to provide rotation to a lower tubular, such that the upper and lower tubulars may be made up/broken out from one another, also so that string of tubulars may be rotated for drilling purposes without requiring a rotary table. Also, an apparatus and method for circulating fluid through a tubular string has a first fluid conduit for supplying fluid to the bore of an upper tubular to be made up into or broken out from the tubular string and a second fluid conduit for supplying fluid to the bore of the tubular string, which allows continuous circulation of fluid to occur whilst running the string into/pulling the string from, a borehole and also whilst making up tubulars into/breaking out tubulars from the string. Also, an upper seal for sealing about a portion of the outer circumference of a tubular to be made up onto or broken out from the string and a lower seal means for sealing about a portion of the outer circumference of the string, where the upper seal is an elastomeric ring which has an inner diameter substantially the same as the outer diameter of the tubular. Also, a valve mechanism includes a rotatable plate member and at least one bore. The plate member is moveable between obturation and non-obturation of the tubular. Also, a safety slip to prevent at least one tubular slipping therein has first and second arrangements of grips which are coupled to one another, preferably by a biasing mechanism.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

1        "Apparatus and Method"

2

3        The present invention relates to an apparatus and  
4        method of drilling boreholes in the ground or subsea  
5        surface, and also to an apparatus and method for use  
6        in workovers, well maintenance and well  
7        intervention, and particularly, but not exclusively  
8        relates to apparatus and method for use in  
9        hydrocarbon exploration, exploitation and  
10       production, but could also relate to other uses such  
11       as water exploration, exploitation and production.

12

13       Conventional drilling operations for hydrocarbon  
14       exploration, exploitation and production utilise  
15       many lengths of individual tubulars which are made  
16       up into a string, where the tubulars are connected  
17       to one another by means of screw threaded couplings  
18       provided at each end. Various operations require  
19       strings of different tubulars, such as drill pipe,  
20       casing and production tubing.

21

1 The individual tubular sections are made up into the  
2 required string which is inserted into the ground by  
3 a make up/break out unit, where the next tubular to  
4 be included in the string is lifted into place just  
5 above the make up/break out unit. A first  
6 conventional method of doing this uses a single  
7 joint elevator system which attaches or clamps onto  
8 the outside surface of one tubular section and which  
9 then lifts this upwards. A second conventional  
10 method for doing this utilises a lift nubbin which  
11 comprises a screw thread which engages with the box  
12 end of the tubular such as drill pipe, and the lift  
13 nubbin and tubular are lifted upwards by a cable.  
14 However, this second method in particular can be  
15 relatively dangerous since the lift nubbin and  
16 tubular will tend to sway uncontrollably as they are  
17 being pulled upwards by the cable.

18

19 From a second aspect, conventional drilling rigs  
20 utilise a make up/break out system to  
21 couple/decouple the tubular pipe sections from the  
22 tubular string. A conventional make up/break out  
23 system comprises a lower set of tongs which are  
24 brought together to grip the lower pipe like a vice,  
25 and an upper set of tongs which firstly grip and  
26 then secondly rotate the upper pipe relative to the  
27 lower pipe and hence screw the two pipes together.  
28 In addition to this conventional make up/break out  
29 system, a conventional drilling rig utilises a  
30 rotary unit to provide rotation to the drill string  
31 to facilitate drilling of the borehole, where the  
32 conventional rotary unit is either a rotary table

1 provided on the drill rig floor or a top drive unit  
2 which is located within the drilling rig derrick.

3

4 According to a first aspect of the present invention  
5 there is provided an apparatus for handling  
6 tubulars, the apparatus comprising a pair of  
7 substantially vertical tracks;  
8 a rail mechanism movably connected to each track;  
9 and

10 a coupling mechanism, associated with the rail  
11 mechanism, for coupling to a tubular; and  
12 a movement mechanism to provide movement to the rail  
13 mechanism.

14

15 According to a second aspect of the present  
16 invention there is provided a method of handling  
17 tubulars, the method comprising:-  
18 providing a rail mechanism, the rail mechanism being  
19 associated with a coupling mechanism for coupling to  
20 a tubular, and the rail mechanism being movably  
21 connected to a substantially vertical track;  
22 coupling the coupling mechanism to a tubular; and  
23 operating a movement mechanism to move the rail  
24 mechanism.

25

26 The substantially vertical tracks are preferably  
27 secured to a frame which is typically a derrick of a  
28 drilling rig. The pair of substantially vertical  
29 tracks are preferably arranged about the  
30 longitudinal axis of a borehole mouth, such that the  
31 pair of tracks and the borehole mouth lie on a

1 common plane, with one track at either side of the  
2 borehole mouth.

3

4 Preferably, the rail mechanism is suitably connected  
5 to the respective track by any suitable means such  
6 as runners or rollers and the like.

7 The movement mechanism may comprise a motive means  
8 associated with the runners or rollers and the like.

9 Alternatively, the movement mechanism may comprise a  
10 cable, winch or the like coupled at one end to the  
11 rail mechanism and coupled at the other end to a  
12 motor and real arrangement or a suitable  
13 counterweight arrangement or a suitable  
14 counterbalance winch hoisting or the like.

15

16 Preferably, the coupling mechanism comprises a  
17 suitable coupling for coupling to the tubular, where  
18 the suitable coupling may comprise a member provided  
19 with a screw thread thereon for screw threaded  
20 engagement with one end of the tubular.

21 Alternatively, the suitable coupling may comprise a  
22 vice means to grip the end of the tubular.

23 Alternatively, the suitable coupling may comprise a  
24 fluid swivel which couples directly to the end of  
25 the tubular, or indirectly to the end of the tubular  
26 via a kelly. Typically, the derrick may be provided  
27 with a tubular rack for storing tubulars, and a ramp  
28 which may extend downwardly at an angle from the  
29 lower end of the derrick toward the tubular rack,  
30 and a tubular guide track may also be provided at  
31 one or both sides of the ramp.

32

1 According to a third aspect of the present invention  
2 there is provided an apparatus for handling a  
3 tubular, the apparatus comprising at least one  
4 substantially vertical track;  
5 a coupling mechanism, connected to the track, for  
6 coupling to a tubular;  
7 a pair of moveable members which are hingedly  
8 connected to both the coupling mechanism and the  
9 vertical track, such that movement of the pair of  
10 moveable members results in movement of the coupling  
11 mechanism substantially about a longitudinal axis of  
12 the track.

13

14 According to a fourth aspect of the present  
15 invention there is provided a method of handling a  
16 tubular, the method comprising providing at least  
17 one substantially vertical track;  
18 connecting a coupling mechanism to the track, the  
19 coupling mechanism for coupling to a tubular;  
20 providing a pair of moveable members which are  
21 hingedly connected to both the coupling mechanism  
22 and the vertical track; and  
23 moving the pair of moveable members to move the  
24 coupling mechanism substantially about a  
25 longitudinal axis of the track.

26

27 Preferably, a rail mechanism is provided and which  
28 is movably connected to the track, and typically,  
29 the coupling mechanism is associated with the rail  
30 mechanism. More preferably, the pair of movable  
31 members are hingedly connected to both the coupling  
32 mechanism and the rail mechanism.

1  
2     Preferably, there are a pair of substantially  
3     vertical tracks, and the substantially vertical  
4     tracks are preferably secured to a frame which is  
5     typically a derrick of a drilling rig. The pair of  
6     substantially vertical tracks are preferably  
7     arranged about the longitudinal axis of a borehole  
8     mouth, such that the pair of tracks and the borehole  
9     mouth lie on a common plane, with one track at  
10   either side of the borehole mouth. Typically, the  
11   movement of the pair of movable members results in  
12   movement of the coupling mechanism substantially  
13   about the longitudinal axis of the track such that a  
14   longitudinal axis of a tubular coupled to the  
15   coupling mechanism is substantially coincident with  
16   the longitudinal axis of the borehole mouth.

17  
18   Preferably, a motive means is provided to permit  
19   movement of the pair of moveable members, where the  
20   motive means may be a suitable motor such as a  
21   hydraulic motor.

22  
23   According to a fifth aspect of the present  
24   invention, there is provided a tong apparatus, the  
25   tong apparatus comprising:-  
26   an upper tong having a gripping means for gripping a  
27   tubular, the upper tong further comprising a  
28   rotation mechanism to provide rotation to the  
29   gripping means to provide rotation to said tubular;  
30   and  
31   a lower tong having a gripping means for gripping a  
32   tubular, the lower tong further comprising a

1       rotation mechanism to provide rotation to the  
2       gripping means to provide rotation to said tubular.

3

4       According to a sixth aspect of the present  
5       invention, there is provided a method of providing  
6       rotation to at least one tubular, the method  
7       comprising:-

8       providing an upper tong having a gripping means for  
9       gripping a tubular, the upper tong further  
10      comprising a rotation mechanism to provide rotation  
11      to the gripping means;  
12      providing a lower tong having a gripping means for  
13      gripping a tubular, the lower tong further  
14      comprising a rotation mechanism to provide rotation  
15      to the gripping means; and  
16      operating at least the rotation mechanism of the  
17      upper tong to provide rotation to said tubular.

18

19      Preferably, the method further comprises operating  
20      the rotation mechanism of the lower tong to provide  
21      rotation to said tubular.

22

23      Typically, the upper tong comprises a plurality of  
24      gripping means. Preferably, a range of gripping  
25      means can be utilised to grip differing diameters of  
26      tubulars.

27

28      Preferably, a motive means is provided to actuate  
29      the rotation mechanism, where the motive means may  
30      be a hydraulic motor having a suitable hydraulic  
31      fluid power supply.

32

1 Preferably, the lower tong comprises a plurality of  
2 gripping means. Preferably, a range of gripping  
3 means can be utilised to grip differing diameters of  
4 tubulars. Preferably, a motive means is provided to  
5 actuate the rotation mechanism, where the motive  
6 means may be a hydraulic motor having a suitable  
7 hydraulic fluid power supply. Preferably, the lower  
8 tong further comprises a turntable bearing means  
9 which support ring gear of the gripping means.

10 Typically, the lower tong further comprises a  
11 breaking system which permits controlled release of  
12 residual tubular string torque.

13

14 Preferably, a travelling slip mechanism is also  
15 provided and which is capable of engaging at least a  
16 portion of the outer circumference of a tubular  
17 string, and preferably, the travelling slip is  
18 capable of being rotated with respect to the derrick  
19 by means of a rotary bearing assembly mechanism.

20 Typically, the travelling slip is provided with a  
21 vertical movement mechanism which can be actuated to  
22 move the travelling slip and the engaged tubular  
23 string in one or both vertical directions.

24

25 According to a seventh aspect of the present  
26 invention, there is provided an apparatus for  
27 circulating fluid through a tubular string, the  
28 string comprising at least one tubular, the  
29 apparatus comprising:-

30 a first fluid conduit for supplying fluid to the  
31 bore of an upper tubular to be made up into or  
32 broken out from the tubular string; and

1 a second fluid conduit for supplying fluid to the  
2 bore of the tubular string.

3

4 According to an eighth aspect of the present  
5 invention, there is provided a method of circulating  
6 fluid through a tubular string, the string  
7 comprising at least one tubular, the method  
8 comprising:-

9 providing a first fluid conduit for supplying fluid  
10 to the bore of an upper tubular to be made up into  
11 or broken out from the tubular string; and  
12 providing a second fluid conduit for supplying fluid  
13 to the bore of the tubular string.

14

15 Preferably, the first fluid conduit is releasably  
16 engageable with an upper end of the upper tubular.

17 Preferably, the first fluid conduit is provided with  
18 a valve mechanism which can be operated to permit  
19 the flow of fluid into or deny the flow of fluid  
20 into the first fluid conduit and/or upper end of the  
21 tubular.

22

23 Preferably, one end of the second fluid conduit is  
24 in fluid communication with a chamber, and  
25 typically, the second fluid conduit is provided with  
26 a valve mechanism which can be operated to permit  
27 the flow of fluid into, or deny the flow of fluid  
28 into, the second fluid conduit and/or the chamber.

29

30 Preferably, the chamber is adapted to permit a  
31 tubular to be made up into, or broken out from, a  
32 tubular string. The chamber typically comprises a

1       bore, which is preferably arranged to be  
2       substantially vertical, and is more preferably  
3       arranged to be coincident with the longitudinal axis  
4       of the mouth of the borehole. Typically, the  
5       chamber comprises an upper port into which the said  
6       tubular can be inserted into or removed from the  
7       chamber. Preferably, a valve mechanism is provided  
8       and is actuatable to seal the bore of the chamber,  
9       typically at a location below the upper port.  
10      Preferably, an upper seal is provided, where the  
11       upper seal is preferably located above the said  
12       location, and where the upper seal is arranged to  
13       seal around at least a portion of the circumference  
14       of the said tubular. Typically, a lower seal is  
15       provided, where the lower seal is preferably located  
16       below the said location, and where the lower seal is  
17       arranged to seal around at least a portion of the  
18       circumference of the tubular string.  
19  
20      Preferably, a valve system comprising one or more  
21       further valves is provided to control the supply of  
22       fluid to the first fluid conduit valve mechanism and  
23       second fluid conduit mechanism.  
24  
25      Typically, the method comprises the further steps of  
26       inserting the lower end of the upper tubular into  
27       the upper port, where the valve mechanism typically  
28       denies the flow of fluid into the first fluid  
29       conduit. At this point, the valve mechanism seals  
30       the bore of the chamber. Thereafter, the upper seal  
31       seals around at least a portion of the circumference  
32       of the tubular, and the valve mechanism of the

1 second fluid conduit is operated to permit the flow  
2 of fluid into the chamber, preferably at a location  
3 below the valve mechanism sealing the bore of the  
4 chamber, such that fluid flows into the upper end of  
5 the tubular string.

6

7 The method preferably comprises the further steps of  
8 operating the valve mechanism to permit the flow of  
9 fluid into the first fluid conduit and upper end of  
10 the tubular. Preferably, thereafter, the valve  
11 mechanism is actuated to open the bore of the  
12 chamber, and thereafter, the valve mechanism is  
13 operated to deny the flow of fluid into the second  
14 fluid conduit. Thereafter, the tubular is  
15 preferably made up into the tubular string, and  
16 thereafter, the first fluid conduit is typically  
17 released from engagement with the upper end of the  
18 upper tubular.

19

20 According to a ninth aspect of the present  
21 invention, there is provided an apparatus for

22 providing a seal between a tubular to be made up in  
23 to or broken out from a tubular string, the tubular  
24 string comprising at least one tubular, the  
25 apparatus comprising:-

26 an upper seal means for sealing about a portion of  
27 the outer circumference of the said tubular to be  
28 made up onto or broken out from the string;  
29 a lower seal means for sealing about a portion of the  
30 outer circumference of the string; and  
31 the upper seal comprising an elastomeric ring which  
32 is adapted to have an inner diameter substantially

1 the same as the outer diameter of at least a portion  
2 of the tubular.

3

4 Preferably, the elastomeric ring is formed from a  
5 suitable material such as rubber. Typically, the  
6 lower seal also comprises an elastomeric ring which  
7 is adapted to have an inner diameter substantially  
8 the same as the outer diameter of at least a portion  
9 of tubular string.

10

11 According to a tenth aspect of the present invention  
12 there is provided a valve mechanism for use in  
13 providing a seal between two tubulars, the valve  
14 mechanism comprising:-

15 a plate member which is capable of rotation about an  
16 axis;

17 at least one bore formed through the plate member;  
18 the plate member being arranged such that it is  
19 capable of movement between a first configuration in  
20 which a portion of the plate member obturates the  
21 longitudinal axis of at least one of the tubulars;  
22 and

23 a second configuration in which the bore is  
24 concentric with the longitudinal axis of at least  
25 one of the tubulars.

26

27 According to an eleventh aspect of the present  
28 invention there is provided a method of providing a  
29 seal between two tubulars, the method comprising:-  
30 providing a plate member which is capable of  
31 rotation about an axis;  
32 the plate member having at least one bore;

1       wherein the plate member is capable of being rotated  
2       between a first configuration in which a portion of  
3       the plate member obturates the longitudinal axis of  
4       at least one of the tubulars; and  
5       a second configuration in which the bore is  
6       concentric with the longitudinal axis of at least  
7       one of the tubulars.

8

9       Preferably, the plate member is capable of being  
10      rotated between a first configuration from which a  
11      portion of the plate member obturates the  
12      longitudinal axis of both of the tubulars, and a  
13      second configuration in which the bore is concentric  
14      with the longitudinal axis of both of the tubulars,  
15      both of the tubulars being concentric with one  
16      another.

17

18      Preferably, the plate member is arranged within a  
19      chamber, such that the radius of the plate member is  
20      perpendicular to the longitudinal axis of both  
21      tubulars. Preferably, the plate member is  
22      substantially circular, and more preferably, the  
23      centre axis of the plate member is off-centre with  
24      respect to the longitudinal axis of both tubulars.

25

26      According to a twelfth aspect of the present  
27      invention, there is provided an apparatus to prevent  
28      a tubular slipping therein, the apparatus comprising  
29      a first arrangement of grips adapted to grip the  
30      tubular, and a second arrangement of grips adapted  
31      to grip the tubular, characterised in that the first

1 and second arrangements of grips are coupled to one  
2 another.

3

4 Preferably the first and second arrangements of  
5 grips are coupled to one another by a coupling  
6 mechanism which is more preferably a biasing  
7 mechanism. Preferably the biasing mechanism is  
8 arranged to bias the first and second arrangements  
9 of grips away from one another. Preferably at least  
10 one of or more preferably both of each of the first  
11 and second arrangements of grips comprise a first  
12 and second portions wherein the first portion is  
13 coupled to the second portion by a tapered surface  
14 and preferably a moveable locking mechanism, such  
15 that the first portion is capable of moving with  
16 respect to the second portion along the tapered  
17 surface.

18

19 Preferably the first arrangements of grips are  
20 located vertically below the second arrangements of  
21 grips and the first arrangements of grips comprise a  
22 relatively large surface area for gripping the  
23 tubular and are the primary gripping arrangement.

24

25 Typically the second arrangement of grips comprise a  
26 relatively smaller surface area for gripping the  
27 tubular and provide a backup or safety gripping  
28 arrangement.

29

30 Preferably a lower face of the second arrangement of  
31 grips is coupled to an upper face of the first  
32 arrangement of grips and the upper face of the first

1 arrangement of grips is of a larger surface area  
2 than a lower face of the first arrangement of grips.

3

4 Preferably the first arrangement of grips comprise a  
5 stop means for preventing movement of the second  
6 arrangement of grips in a direction, preferably  
7 radially, away from the tubular being gripped.

8

9 Embodiments of the invention will now be described,  
10 by way of example only, with reference to the  
11 accompanying drawings, in which:-

12

13 Fig. 1 is a perspective view of a drilling rig  
14 incorporating aspects of the present invention;

15 Fig. 2 is a portion of the drilling rig of Fig.  
16 1 in a first configuration;

17 Fig. 3a is a portion of the drilling rig of  
18 Fig. 1 in a second configuration;

19 Fig. 3b is a more detailed perspective view of  
20 the portion of the drilling rig of Fig. 3a;

21 Fig. 4 is a front perspective view of a portion  
22 of the drilling rig of Fig. 3a;

23 Fig. 5 is a perspective view looking upwardly  
24 at the portion of the drilling rig of Fig. 3a;

25 Fig. 6 is a perspective view of a ramp and  
26 drill pipe loading area of the drilling rig of  
27 Fig. 1;

28 Fig. 7a is a cross-sectional side view of the  
29 derrick of the drilling rig of Fig. 1;

30 Fig. 7b is a front view of the derrick of Fig.  
31 7a;

1       Fig. 8a is a cross-sectional more detailed view  
2       of a portion of the apparatus of Fig. 8b;  
3       Fig. 8b is a front cross-sectional view of a  
4       portion of the derrick of the drilling rig of  
5       Fig. 1;  
6       Fig. 9a is a cross-sectional more detailed view  
7       of a portion of the derrick of Fig. 9b;  
8       Fig. 9b is a front cross-sectional view of the  
9       derrick of the drilling rig of Fig. 1;  
10      Fig. 10a is a more detailed view of a portion  
11      of the apparatus of Fig. 10b;  
12      Fig. 10b is a front view of the derrick of Fig.  
13      1;  
14      Fig. 11a is a more detailed view of a portion  
15      of the apparatus of Fig. 11b;  
16      Fig. 11b is a front view of the derrick of Fig.  
17      1;  
18      Fig. 12a is a side view of the derrick of Fig.  
19      1;  
20      Fig. 12b is a front view of the derrick of Fig.  
21      1;  
22      Fig. 13a is a side view of the derrick of Fig.  
23      1;  
24      Fig. 13b is a front view of the derrick of Fig.  
25      1;  
26      Fig. 14a is a more detailed view of the portion  
27      of the apparatus of Fig. 14b;  
28      Fig. 14b is a front view of the derrick of Fig.  
29      1;  
30      Fig. 15a is a side view of the derrick of Fig.  
31      1;

1       Fig. 15b is a front view of the derrick of Fig.  
2       1;  
3       Fig. 16a is a side view of the derrick of Fig.  
4       1;  
5       Fig. 16b is a front view of the derrick of Fig.  
6       1;  
7       Fig. 17a is a front view of upper and lower  
8       tongs mounted within a snubbing unit;  
9       Fig. 17b is a perspective view of a portion of  
10      the snubbing unit of Fig. 17a;  
11      Fig. 17c is a top view of a portion of the  
12      snubbing unit of Fig. 17a;  
13      Fig. 17d is a rear view of a portion of the  
14      snubbing unit of Fig. 17a;  
15      Fig. 17e is a side view of a portion of the  
16      snubbing unit of Fig. 17a;  
17      Fig. 18 is a more detailed part cross-sectional  
18      view of a portion of the snubbing unit of Fig.  
19      17a;  
20      Fig. 19 is a more detailed part cross-sectional  
21      view of the snubbing unit of Fig. 17a;  
22      Fig. 20 is a more detailed part cross-sectional  
23      view of a portion of the snubbing unit of Fig.  
24      17a;  
25      Fig. 21 is a more detailed part cross-sectional  
26      view of a portion of the snubbing unit of Fig.  
27      17a;  
28      Fig. 22 is a more detailed part cross-sectional  
29      view of a portion of the snubbing unit of Fig.  
30      17a;  
31      Fig. 23 is a perspective view of a valve plate  
32      of the snubbing unit of Fig. 17a;

1       Fig. 24 is a schematic view of the snubbing  
2       unit of Fig. 17a showing a continuous  
3       circulation configuration with a main valve  
4       closed;  
5       Fig. 25 is a schematic view of the snubbing  
6       unit of Fig. 17a in a continuous circulation  
7       configuration with the main valve open;  
8       Fig. 26 is a schematic view of the snubbing  
9       unit of Fig. 17a incorporating a stripper  
10      design;  
11      Fig. 27 is a schematic view of the snubbing  
12      unit of Fig. 17a incorporating a ram design in  
13      a first configuration;  
14      Fig. 28 is a schematic view of the snubbing of  
15      Fig. 17a incorporation a ram design in a second  
16      configuration;  
17      Fig. 29 is a cross-sectional view of a first  
18      embodiment of a safety slip mechanism, in  
19      accordance with a twelfth aspect of the present  
20      invention, in an open configuration;  
21      Fig. 30 is a cross-sectional view of the safety  
22      slip mechanism of Fig. 29 in a closed  
23      configuration;  
24      Fig. 31 is a cross-sectional view of a portion  
25      of the safety slip mechanism of Fig. 29;  
26      Fig. 32 is a half cross sectioned view of a  
27      second embodiment of a safety slip mechanism,  
28      in accordance with the twelfth aspect of the  
29      present invention, in a closed configuration;  
30      Fig. 33 is a cross-sectional view of the second  
31      embodiment of the safety slip mechanism of Fig.  
32      32, but in an open configuration; and

1           Fig. 34 is a cross-sectional plan view of the  
2           safety slip mechanism of Fig. 33 through  
3           section C-C.

4  
5           Fig. 1 shows a drilling rig generally designated at  
6           100. The drilling rig 100 is particularly suited  
7           for use in the business of exploration, exploitation  
8           and production of hydrocarbons, but could also be  
9           used for the same purposes for other gases and  
10          fluids such as water. With regard to hydrocarbons,  
11          the drilling rig 100 can be used for operations such  
12          as, but not limited to, snubbing, side tracks, under  
13          balanced drilling, work overs and plug and  
14          abandonments. The drilling rig 100 can be utilised  
15          for land operations (as shown in Fig. 1) as well as  
16          in marine operations since it can be modified to be  
17          installed on an offshore drilling rig, a drill ship  
18          or other floating vessels.

19  
20          The drilling rig 100 comprises a derrick 102 which  
21          extends vertically upwardly from a rig floor 8,  
22          where the rig floor 8 is carried by a suitable  
23          arrangement of supports 104 which are secured by  
24          appropriate means to the ground 1 or floating vessel  
25          top side 1.

26  
27          As can be seen in Figs. 1 to 4 and 6, the drilling  
28          rig 100 optionally includes a ramp 5 which extends  
29          downwardly at an angle from the rig floor 8. The  
30          ramp 5 can be used by personnel as an evacuation  
31          slide 5 if it is required that the personnel quickly  
32          evacuate the drilling rig 100. A drill pipe guide

1      track 7a, 7b is located at each side of the slide 5  
2      and which fully extends from the drill rig floor 8  
3      to the ground 1. A drill pipe rack 6a, 6b is  
4      located at the outer side of each respective drill  
5      pipe guide track 7a, 7b, where the rack 6a, 6b is  
6      capable of holding a plurality of tubular drill pipe  
7      lengths, such as drill pipe 17. Each rack 6a, 6b  
8      comprises two or more kickover troughs (not shown)  
9      spaced along the length of the rack 6a, 6b, where  
10     the troughs can be operated to move lengths of drill  
11     pipe 17 from the rack 6a, 6b to the respective track  
12     7a, 7b or vice versa as required, and do this by  
13     being angled either respectively inwardly or  
14     outwardly by approximately two or three degrees  
15     either way. A rope or counterbalance winch  
16     arrangement (not shown) is also provided for each  
17     pipe guide track 7, such that the rope/winch  
18     arrangement can be operated to pull pipes 17 from  
19     the lower end of the track 7a, 7b up to the drill  
20     rig floor 8. The rope/winch arrangement can also be  
21     operated to lower pipe 17 from the drill rig floor 8  
22     to the lower end of the track 7a, 7b.

23  
24     It should however be noted that the downwardly  
25     angled fire evacuation slide 5 is an optional  
26     feature of the drilling rig 100.

27  
28     Fig. 1 also shows an arm runner 9a, 9b being  
29     moveably located on a respective derrick dolly track  
30     4a, 4b. As shown in Figs. 3b, 7a and 8b for  
31     example, each arm runner 9a, 9b is provided with a  
32     pair of articulated pipe arms 12 which are hingedly

1 attached at one end to the respective arm runner 9a,  
2 9b and are hingedly attached at the other end to a  
3 respective pipe handler fluid swivel 13a, 13b. This  
4 arrangement allows the fluid swivel 13a, 13b to be  
5 moved, by means of suitable motors (not shown),  
6 inwardly from the plane parallel to the longitudinal  
7 axis of the respective dolly track 4a, 4b to the  
8 plane parallel with the longitudinal axis of the  
9 borehole, such that the articulated pipe arms 12 act  
10 like a collapsible parallelogram. A respective  
11 goose neck pipe 18a, 18b is provided at the upper  
12 end of the respective fluid swivel 13a, 13b and is  
13 in sealed fluid communication with the internal bore  
14 of the respective fluid swivel 13a, 13b. A suitable  
15 pipe end coupling is provided at the lower end of  
16 each fluid swivel 13, where this pipe end coupling  
17 may suitably be a screw thread coupling for  
18 connection with the box end of a drill pipe 17. A  
19 wire pulley 10a, 10b is provided for each arm runner  
20 9, and is secured at one end to the upper portion of  
21 the arm runner 9, where the other end of the wire  
22 pulley 10 is coupled to a suitable lifting/lowering  
23 mechanism, which may be a motor and reel  
24 arrangement, or may be a suitable counter weight  
25 arrangement, or may be a suitable counter balance  
26 winch hoisting (not shown).

27

28 Alternatively however, the dolly tracks 4A, 4B of  
29 the derrick 102 could be modified to be the same as  
30 the dolly tracks of a conventional rig in which  
31 there will be a block (not shown) and top drive (not  
32 shown), and in this case the arm runners 9A, 9B are

1 also suitably modified such that they can be used in  
2 conventional dolly tracks of a conventional rig.

3

4 A method of operating the pipe handling mechanism,  
5 in accordance with an aspect of the present  
6 invention, will now be described. Drill pipe 17a is  
7 lifted up one of the guide tracks 7a as previously  
8 described, until the upper end of the drill pipe 17a  
9 is located in relatively close proximity to the pipe  
10 coupling provided on the first pipe handler swivel  
11 13a. The box end of the drill pipe 17a is then  
12 coupled to the pipe end coupling of the fluid swivel  
13 13a, such that the pipe handling mechanism is in the  
14 configuration shown in Fig. 2. The cable 10a  
15 lifting/lowering mechanism is then operated such  
16 that the arm runner 9a, and hence drill pipe 17a is  
17 lifted upwardly to the configuration shown in Figs.  
18 1, 3a, 3b, 4, 5, 7a and 7b, until the arm runner 9a  
19 and hence drill pipe 17a are in the configuration  
20 shown in Figs. 8a and 8b. It should be noted that  
21 it is preferred that the drill pipe 17a is lifted  
22 upwardly at a downwardly projecting angle, and this  
23 provides the advantage that the lower end of the  
24 drill pipe 17a is kept well clear of the rig floor  
25 8.

26

27 However, it should be noted that the other arm  
28 runner 9b and drill pipe 17b have already been moved  
29 in a similar manner, and the associated motor has  
30 been operated to move the drill pipe 17b such that  
31 the articulated pipe arms 12 have moved inward and  
32 the drill pipe 17b is co-axial with the borehole.

1

2 A make up/break out unit will now be described for  
3 making up the drill string, in accordance with the  
4 present invention.

5

6 A make up/break out unit in the form of a snubbing  
7 unit is generally designated at 20 and is shown in  
8 Fig. 17(a) as comprises a frame 106 which is made up  
9 of a work basket base 106a, support column spacers  
10 106b, work basket support column 106c, and snubbing  
11 unit base 106d.. An upper tong 108 and a lower tong  
12 109 are mounted within a tong frame 110 which is  
13 further mounted within the work basket base 106a as  
14 can be seen in Fig. 17a, where the tong frame 110  
15 can be seen in isolation in Figs. 17b to 17e.

16

17 It should be noted that the upper tong 108 can be  
18 used to make up/break out work strings, casing and  
19 production tubulars as large as  $8\frac{5}{8}$  inches in  
20 diameter, although if modified in a suitable  
21 fashion, then it could be used for larger diameters  
22 if required.

23

24 The lower tong 109 is also known as a rotary back up  
25 109, and is used to rotate the drill string 17 at  
26 speed and torque required for milling, side tracking  
27 and drilling. However, the lower tong 109 also acts  
28 as a back up to the upper tong 108 when making up or  
29 breaking out connections.

30

31 Another main component of the snubbing unit 20 is a  
32 rotary bearing assembly 112 which is coupled to the

1      upper surface of a cylinder plate 116. The moveable  
2      bearing of the rotary bearing 112 is secured to a  
3      set of travelling slips 114 which are used to engage  
4      the drill pipe 17, and hence the rotary bearing  
5      assembly 112 allows the travelling slips 114 to  
6      rotate whilst the slips 114, as will subsequently be  
7      described, support the weight of the drill string to  
8      permit simultaneous vertical pipe manipulation and  
9      rotation of the work string. As will also be  
10     described, a hydraulic swivel or hydraulic bypass  
11     (not shown) is integrated into the rotary bearing  
12     assembly 112 and allows the slips 114 to be remotely  
13     operated at all times and eliminate the need to  
14     make/break hose connections.

15  
16     Mounting the tong system above the snubbing unit 20  
17     travelling slips 114 eliminates the need to swing  
18     tongs 108, 109 to engage and disengage the drill  
19     pipe 17 at every drill pipe joint connection by  
20     allowing the drill pipe 17 and drill pipe joints to  
21     pass through the tongs 108, 109 during tripping  
22     operations. The tongs 108, 109 and travelling slips  
23     114 have a manually operated "large-bore" feature  
24     which allows their bore to be quickly increased to  
25     allow passage of downhole tools with diameters up to  
26     and over 11 inches. A remotely mounted control  
27     panel can be utilised to operate all tong 108, 109  
28     functions at any jack position without placing  
29     personnel at dangerous positions, and this enhances  
30     safety and speeds tripping operations.  
31     Additionally, this has the advantage that operators  
32     will be able to make up/break out connections while

1 the drill pipe 17 is being moved by the snubbing  
2 unit 20. It should be noted that reactive make  
3 up/break out torques are transferred between the  
4 tongs 108, 109 via the frame 106 and a reaction  
5 column 118 (as shown in Fig. 17(a) and 14 (as shown  
6 in Fig. 4), which is coupled to the frame 106 by  
7 means of a roller joint 120. Hence, the snubbing  
8 unit 20 can move vertically upwardly or downwardly  
9 by means of the roller joint 120. Hydraulic jacking  
10 cylinders 122, of which there are preferably four,  
11 are arranged, and act, between the stationary  
12 snubbing unit base 106d and the moveable cylinder  
13 plate 116, and actuation of the hydraulic jacking  
14 cylinders 122 provides movement to the cylinder  
15 plate 116 and hence snubbing unit 20.

16

17 Fig. 17a also shows the location of fixed/stationary  
18 slips 124 as being mounted to the upper section of  
19 the BOP stack 126, where the fixed slips 124 and BOP  
20 stack 126 are stationary with respect to the drill  
21 rig floor 8. Hence, the snubbing unit 20 is  
22 moveable by the hydraulic jacking cylinders 122 with  
23 respect to the fixed slips 124.

24

25 The active make up/break out torques are transferred  
26 between the upper tong 108 and lower rotary back up  
27 109 by means of an integral reaction column in the  
28 form of a closed head tong leg assembly 113 and the  
29 substructure of the derrick 102. This allows the  
30 snubbing unit 20 to accept conventional hydraulic  
31 load cell and torque gauge assemblies and/or

1        electronic load cells required for computerised  
2        tubular make up control.

3

4        Reactive drilling torques will be transferred back  
5        to the derrick 102 by means of the reaction column  
6        118 (shown in Fig. 3(b) as being securely mounted to  
7        the derrick 102) and roller joint 120. Hence, this  
8        rigid mounting system allows high speed work string  
9        rotation during milling/drilling operations with a  
10       minimum of rotating components, these being the  
11       travelling slips 114 and a portion of the rotary  
12       bearing assembly 112, which reduces vibration and  
13       hazards associated with exposed rotating equipment.

14

15       The upper tong 108 will now be described in detail.  
16       The upper tong 108 provides means to make up and  
17       break out tubing, casing or drill pipe during  
18       tripping and snubbing operations, and is  
19       hydraulically powered. The upper tong 108 comprises  
20       three sliding jaws (not shown) which virtually  
21       encircle the drill pipe 17 to maximise torque while  
22       minimising marking and damage to the outer surface  
23       of the drill pipe 17. The upper tong 108 is  
24       provided with a cam operated jaw system (not shown)  
25       which can be opened to allow passage of work string  
26       tool joints as well as tubing and casing couplings.  
27       A range of jaw systems can be used for different  
28       dies such as dove tail strip dies which are used  
29       with drill pipe tool joints, and wrap around dies  
30       which are used with tubing or casing. The upper  
31       tong 108 can also be used for running CRA tubulars  
32       (such as 13% to 26% Cr tubulars) with grit faced

1 dies. Additionally, non-marking aluminium dies can  
2 also be used with low friction jaws. Additionally,  
3 electronic turns encoder(s) and electronic load  
4 cell(s) can be provided to permit torque turn  
5 compatibility with electronic OCTG analysis systems,  
6 which can provide a record, such as a computer print  
7 out, of the quality of the make up between the  
8 respective end joints of two tubulars.

9 Additionally, it should be noted that the dies can  
10 be replaced whilst pipe passes through the upper  
11 tong 108. Also, the upper tong 108 can be manually  
12 operated such that the tong bore can be increased to  
13 allow passage of tools with diameters up to 11.06  
14 inches. The upper tong 108 is powered by twin two  
15 speed hydraulic motors (not shown) which provide  
16 speeds and torque capable of spinning and  
17 making/breaking high torque connections. The upper  
18 tong 108 is provided with a hydraulic power supply  
19 which has a 35 gpm and 3000 psi output (62 hydraulic  
20 Horse Power) which produces 30,000 ft lbs at 9 rpm  
21 and high torque, low speed mode and 15,000 ft lbs at  
22 18 rpm in low torque, high speed mode.

23 Alternatively, the hydraulic motors can provide 24  
24 rpm maximum speed and low torque, high speed mode at  
25 47.6 gpm which is the maximum allowable flow rate  
26 using a standard PVG 120 Danfoss™ valve package,  
27 although alternative valve systems can be used to  
28 provide even higher speeds at higher flow rates.

29 The upper tong 108 can be used for tubulars with a  
30 range from  $2\frac{1}{16}$  inches to  $8\frac{5}{8}$  inches outside  
31 diameter with a range of jaws and dies being  
32 supplied as required to accommodate the varying

1      diameters. The gripping range for jaws being  
2      supplied with dove tail dies is half an inch under  
3      the nominal size of the jaws, and the gripping range  
4      for jaws supplied with wrap around dies is that the  
5      wrap around dies are machined to match specific  
6      tubing, casing, tool joints, couplings or accessory  
7      diameters.

8

9      The lower tong or rotary back up 109 has two  
10     functions. During drilling operations, the rotary  
11     back up 109 generates the torque required for high  
12     speed milling and drilling. This torque is  
13     transferred to the outer diameter of the work or  
14     drill string 17 by means of three sliding jaws.  
15     During tripping operations, the jaws of the rotary  
16     back up 109 are activated to grip the pipe 17 and  
17     resist the torque generated by the upper tong 108  
18     when making up or breaking out the tubular  
19     connections. However, the rotary back up 109  
20     differs from the upper tong 108 in several aspects.  
21     Firstly, the rotary back up 109 has large turntable  
22     bearings (not shown) to support the ring gear (not  
23     shown) instead of a series of dumb bell roller  
24     assemblies (not shown) which are provided on the  
25     upper tong 108. Also, the body of the rotary back  
26     up 109 is sealed and filled with gear oil to protect  
27     the bearings in gear surfaces during extended  
28     periods of drilling. A hydraulically operated  
29     braking system (not shown) is also provided which  
30     allows controlled release of residual work string  
31     torque. However, the rotary back ups 109 drive  
32     train (not shown) is similar to the drive train (not

1 shown) of the upper tong 108, but features different  
2 motor displacements and gear ratios. However, like  
3 the upper tong 108, the rotary back up 109 utilises  
4 three jaws which virtually encircle the pipe 17 to  
5 maximise torque whilst minimising marking and damage  
6 to the outer surface of the pipe 17. The cam  
7 operated jaw system (not shown) of the rotary back  
8 up 109 can be opened to allow passage of tubing and  
9 casing couplings, and the rotary back UP's 109 jaw  
10 systems (not shown) are interchangeable with those  
11 of the upper tong 108. Dovetail strip dies (not  
12 shown) can be provided for the rotary back up's 109  
13 jaws for use with drill pipe tool joints and wrap  
14 around dies can be used for tubing or casing.  
15 Additionally, the dies can be replaced while the  
16 drill pipe 17 passes through the rotary back up 109,  
17 and the rotary back up 109 can be manually operated  
18 to increase it's bore to allow the passage of tools  
19 with diameters up to 11.06 inches. Twin two speed  
20 hydraulic motors (not shown) provides speeds for  
21 milling and drilling operations. A removable lower  
22 pipe guide plate assembly (not shown) is provided  
23 separately for each specific coupling diameter and  
24 assists pipe alignment during jacking operations.  
25  
26 The hydraulic power supply of the rotary back up 109  
27 supplies 145 gpm and 2250 psi output (190 hydraulic  
28 horse power) and produces 7500 ft lbs at 80 rpm in  
29 high speed, low torque mode and 15000 ft lbs at 40  
30 rpm in high torque, low speed mode.  
31

1 The tubular capacity and the gripping range for the  
2 rotary back up 109 is the same as that for the upper  
3 tong 108.

4

5 Referring again to Fig. 17(a), the tong frame 110 is  
6 bolted to the travelling slips 114 via a lower tong  
7 frame 111, although it should be noted that some  
8 configurations may require a separate adapter plate  
9 (not shown). The upper tong 108 is suspended within  
10 the tong frame 111 by double acting spring  
11 assemblies located on legs 113 (see Fig. 17(b))  
12 which extend upward from the rotary back up 109.  
13 The upper tong 108 can be pinned in one of two  
14 positions to facilitate make up of work string tool  
15 joints and connections using couplings. The spring  
16 assemblies (not shown) within legs 113 allow the  
17 upper tong 108 to float  $\pm 2.5$  inches to accommodate  
18 thread lead during make up or break out. An open  
19 throat top guide plate 115 is fixed to the upper end  
20 of legs 113 and is fitted with lifting eyes 117  
21 which enable handling of the tong frame 110. An  
22 optional remotely operated adjustable upper guide  
23 plate assembly can be provided to facilitate hands  
24 off stabbing of tubulars, and hence the remotely  
25 operated adjustable upper guide plate assembly acts  
26 as a hydraulic stabbing guide for the tubulars. The  
27 tong frame 110 is approximately 39 inches wide by 39  
28 inches deep.

29

30 The rotary bearing assembly 112 allows the  
31 travelling slips 114 to rotate under load while the  
32 pipe 17 is being manipulated. The rotary bearing

1 assembly 112 is attached to the upper end of the  
2 cylinder plate 116 of the snubbing unit 20 and  
3 features a flange (not shown) to accommodate the  
4 travelling slip's 114 mounting bolts (not shown).  
5 These loads are transferred into a large diameter  
6 turntable bearing system (not shown) which runs  
7 within a closed housing of the assembly 112 to guard  
8 against contamination. An integral hydraulic swivel  
9 system (not shown) allows continuous slip 114  
10 operation without the need to connect or disconnect  
11 hoses. The swivel features a cooling system (not  
12 shown) to minimise heat build up in seals (not  
13 shown) while the rotary bearing assembly 112 is  
14 being used for extended drilling operations.  
15 Preliminary specifications for the rotary bearing  
16 assembly 112 are as follows.

17

18 Compressive load rating 460,000 pounds

19

20 Tense (snubbing) load  
21 rating 170,000 pounds

22

23 Rotational speed limit (swivel  
24 seal rating) 106 rpm

25

26 Maximum swivel pressures (static  
27 non-rotating conditions) 1500 psi  
28 (note pressure should be bled off swivel while  
29 rotating)

30

31 Maximum swivel coolant pressure 60 psi

32

1 Recommended swivel coolant supply  
2 flow rate 5 - 10 gpm

3

4 The swivel should be cooled by fresh water although  
5 glycerol based antifreeze or equivalent may be  
6 required in cold climates.

7

8 A remote control and instrumentation console may  
9 also be provided and which features direct acting  
10 hydraulic control valves (not shown) to provide  
11 control for the following:-

12

13 i) Tong motor direction manual directional control  
14 which uses a Danfoss PGV 120™ load independent  
15 proportional hydraulic control valve assembly  
16 (not shown) for open loop power unit with a  
17 manual lever operated valve section to control  
18 the tong motor with flow rates to 47.6 gpm.

19

20 ii) Tong motor mode (high torque, low speed or low  
21 torque, high speed).

22

23       iii) Tong torque limiter (manual preset for  
24            automatic dumping, and an electronic solenoid  
25            can add computer dump control).

26

27 iv) Tong backing pin.

28

29 v) Hydraulic system pressure control.

30

31 vi) Rotary back up motor manual directional control

1       which uses a hydraulic control valve assembly  
2       for open loop power unit with a manual lever  
3       operated valve section. One section controls  
4       the rotary back up 109 motors with flow rates  
5       to 145 gpm which is the maximum allowable flow  
6       rate for continuous operation in high speed  
7       mode. Infinitely variable rotational speed  
8       control may be achieved most efficiently  
9       through the use of variable displacement pump  
10      systems. Alternatively, the speed may be  
11      adjusted by throttling the direction of control  
12      valve or through the use of an adjustable flow  
13      control valve.

14

15      vii) Rotary back up 109 motor mode providing for  
16       high torque, low speed or low torque, high  
17       speed.

18

19      viii) Tong backing pin for the rotary back up 109.

20

21      ix) Braking system control.

22

23      x) Torque gauge (hydraulic style) with dampener  
24       valve.

25

26      xi) Hydraulic system pressure gauge.

27

28      Referring now back to Fig. 8a, a tripping operation  
29       into an already drilled borehole will now be  
30       described. By way of explanation, a tripping  
31       operation is performed to insert tools required in  
32       the borehole for a specific downhole operation.

1 With boreholes being many thousands of feet deep,  
2 the length of drill pipe 17 must be included in the  
3 drill string and inserted into the borehole as  
4 quickly as possible.

5

6 A make up/break out mechanism in accordance with the  
7 present invention will now be described.

8

9 Fig. 8a shows the upper end of drill pipe 17c  
10 projecting upwardly from the snubbing unit 20. At  
11 this point, the fixed slips 124, which are located  
12 within a fixed slip housing 3, are energised to  
13 firmly grip against the outer surface of the lower  
14 end of drill pipe 17c, such that the fixed slips 124  
15 are holding the entire weight of the drill string.  
16 The four hydraulic jacking cylinders 122 are then  
17 actuated to raise the snubbing unit 20 upwards until  
18 it reaches the position shown in Figs. 7a and 9a,  
19 such that the upper end of drill pipe 17c and lower  
20 end of drill pipe 17b are located within the  
21 snubbing unit 20. The travelling slips 114 are then  
22 energised to engage the outer surface of drill pipe  
23 17c just below the upper end thereof. The jaws of  
24 the rotary back up 109 are then energised to engage  
25 the outer surface of drill pipe 17c immediately  
26 below the upper end thereof and the jaws of the  
27 upper tong 108 are energised to engage the outer  
28 surface of drill pipe 17b immediately above the  
29 lower end thereof. The fixed slips 124 are then  
30 released and the hydraulic jacking cylinders 122 are  
31 then actuated to move the snubbing unit 20  
32 downwardly. Simultaneously, the upper tong 108 is

1       operated to rotate drill pipe 17b relative to drill  
2       pipe 17c such that the two joints thereof are made  
3       up to the required torque level. Therefore, by the  
4       time snubbing unit 20 has reached the position shown  
5       in Fig. 10a, the joint between drill pipe 17b and  
6       17c has been made up. The pipe handler fluid swivel  
7       13b can then be disengaged from the upper end of  
8       drill pipe 17b and can be moved downwardly on the  
9       arm runner 9b, as shown in Figs. 11b and 12b to pick  
10      up another pipe 17. The fixed slips 124 are then  
11      re-energised to engage the outer surface of drill  
12      pipe 17b, and when this has been done, the  
13      engagement between upper tong 108, rotary back up  
14      109 and the respective drill pipe 17b, 17c can be  
15      released. The hydraulic jacking cylinders 122 are  
16      then actuated once more such that the snubbing unit  
17      20 moves to the configuration shown in Fig. 13a.  
18      The travelling slips 114 are re-energised to grip  
19      the drill pipe 17 and the fixed slips 124 are  
20      released. The hydraulic jacking cylinders 122 are  
21      then actuated to move downwardly such that the  
22      snubbing unit 20 and travelling slips 114 stroke the  
23      drill string 17 into the borehole. A typical length  
24      of travel of the hydraulic jacking cylinders 122,  
25      and hence stroke of the drill string 17, is 13 feet.  
26      The snubbing unit 20 therefore moves from the  
27      configuration shown in Fig. 13a to the configuration  
28      shown in the Fig. 14a and 15a. Additionally,  
29      articulated pipe arms 12a have moved pipe 17a to be  
30      co-axial with the drill pipe 17b.

1 The fixed slips 124 are once again energised to  
2 engage the drill pipe 17b and the travelling slips  
3 114 are released, such that the hydraulic jacking  
4 cylinders 122 move the snubbing unit 20 to the  
5 configuration shown in Fig. 16a so that the upper  
6 end and lower end of respective drill pipes 17b and  
7 17a are located within the snubbing unit 20.

8

9 This process is repeated for as many drill pipe 17  
10 sections as required in order to make up the desired  
11 length of drill string 17.

12

13 This process provides an extremely quick make up (or  
14 if operated in reverse, break out) for a tripping  
15 operation.

16

17 Normally, for tripping operations, rotation of the  
18 drill string is not required. However, for drilling  
19 operations, the drill string 17 is required to be  
20 rotated and also requires that circulation occurs  
21 through the bore of the drill string 17 down to the  
22 drill bit located at the bottom of the drill string  
23 17. The drilling rig 100 is capable of imparting  
24 rotary movement to the drill string 17 without the  
25 requirement for a conventional rotary table or top  
26 drive, and can also provide continuous circulation  
27 through the bore of the drill string 17, as will now  
28 be described.

29

30 The travelling slips 114, as previously described,  
31 are used to lower the drill string 17 into, or raise  
32 the drill string 17 from, the borehole, and the

1 control system for the hydraulic jacking cylinders  
2 can be operated such that the cylinders 122 can push  
3 the drill string 17 into the hole. For instance,  
4 the drilling operation may require that the drill  
5 string 17 is forced down into the hole by a certain  
6 percentage of weight of drill pipe 17, such as 10%  
7 weight. The rotary bearing assembly 112 and the  
8 travelling slips 114 can also be operated to impart  
9 rotation to the drill string 17, either as it is  
10 being inserted into, or pulled from the borehole, or  
11 even whilst the drill string 17 is vertically  
12 stationary.

13

14 Additionally, or alternatively to the rotary bearing  
15 assembly providing the power to rotate the drill  
16 string 17, the rotary backup 109 can be operated to  
17 impart rotation to the drill string 17.

18

19 A continuous circulation apparatus and method in  
20 accordance with the present invention will now be  
21 described, which is particularly for use during a  
22 milling/drilling operation.

23

24 Figs. 18 to 23 show a portion of an apparatus 130 of  
25 the continuous circulation system, with Figs. 24 to  
26 28 showing flow diagrams for the operation thereof.  
27 Fig. 19 shows the continuous circulation apparatus  
28 130 in isolation, and Fig. 18 shows the continuous  
29 circulation apparatus 130 incorporated in the  
30 snubbing unit 20. Referring firstly to Fig. 19,  
31 there is shown a first embodiment of apparatus 130  
32 as comprising an upper seal 132 in the form of a

1 shaffer sealing element 132, a lower seal in the  
2 form of a pair of rams 134a, 134b and a middle full  
3 bore valve 136 in the form of a 10,000 psi plate  
4 valve 136. Housing for these components is also  
5 provided in the form of a shaffer type bonnet 138,  
6 centre housing 140 and a main housing 142. The  
7 shaffer seal 132 is provided with a piston assembly  
8 144 which can be moved upwardly to energise the  
9 shaffer seal 132 around the outer surface of a pipe  
10 17 located in the bore of the shaffer seal 132 by  
11 the introduction of pressured hydraulic fluid into  
12 sealed closed port 146. The piston assembly 144 can  
13 be moved downwardly to release the sealing action of  
14 the shaffer seal 132 on the drill pipe 17 by  
15 introduction of hydraulic fluid into the seal open  
16 port 148.

17

18 It is important to note that the centre spindle 137  
19 of the plate valve 136 is not located on the  
20 intended path of the longitudinal axis of the drill  
21 string 17. However, the main working plane of the  
22 plate valve 136 is perpendicular to the longitudinal  
23 axis of the intended path of travel of the drill  
24 string 17. A pair of circular apertures 150a, 150b  
25 are provided in the plate valve 136, and a pair of  
26 sealing rings 152a, 152b are provided on the upper  
27 surface of the plate valve 136, such that the  
28 centres of the apertures 150a, 150b and sealing  
29 rings 152a, 152b are located at the same radius from  
30 the centre spindle 137. Furthermore, the centres of  
31 the apertures 150a, 150b are located on the same  
32 diameter, and the centres of the sealing rings 152a,

1 152b are also located on the same diameter. The  
2 valve plate 136 is arranged such that, with the  
3 centre spindle 137 being off centre of the  
4 longitudinal axis of the drill string 17, the centre  
5 point of the apertures 150a, 150b and sealing rings  
6 152a, 152b bisect the longitudinal axis of the drill  
7 string 17 as the valve plate 136 rotates. In other  
8 words, the centre spindle 137 is located off centre  
9 by a distance equal to the radius of the centre  
10 lines of the apertures 150 and sealing rings 152.

11

12 As shown most clearly in Fig. 20, a circulating port  
13 154 is formed immediately vertically below the  
14 location of the plate valve 136 and immediately  
15 vertically above the pipe rams 134a, 134b.

16

17 The inner faces of the pipe rams 134a, 134b are  
18 formed such that when the rams 134 are brought  
19 together, they provide a sealing fit around the  
20 outer surface of the drill pipe 17.

21

22 The plate valve 136 is provided with a gearing  
23 surface 156, and an internal hydraulic motor 158  
24 with an appropriately geared drive is also provided,  
25 such that actuation of the hydraulic motor 158  
26 rotates the plate valve 136.

27

28 Optionally, but preferably, a further port 220 (as  
29 shown in Fig. 24) is provided into the inner chamber  
30 of the continuous circulation apparatus 130, where  
31 the further port 220 is located in between the  
32 shaffer sealing element 132 and the plate valve 136.

1 The further port 220 can be opened to purge air from  
2 the pipe joint 17B being introduced into the  
3 apparatus 130 prior to the plate valve 136 being  
4 opened; in this manner the shaffer seal 132 is first  
5 closed around the pipe joint 17B and the further  
6 port 220 is opened such that air may be flushed out  
7 or pumped out of the joint 17B.

8

9 Optionally, but preferably, a joint integrity  
10 checking apparatus is further provided for use with  
11 the continuous circulation apparatus 130; the joint  
12 integrity apparatus (not shown) provides an external  
13 pressure check on the integrity of the pipe joints  
14 that are made up within the continuous circulation  
15 apparatus 130. In order to utilise the joint  
16 integrity apparatus, the pipe joint to be checked is  
17 maintained within the middle of the continuous  
18 circulation apparatus 130, that is in the position  
19 shown in Fig. 25. The rams 134A, 134B are  
20 maintained in the closed configuration, such that  
21 they seal about the upper end of the lower pipe 17C.  
22 Then, either a fluid or more preferably a gas, such  
23 as nitrogen or most preferably helium, is introduced  
24 under pressure into the chamber (the portion  
25 intermediate the circulation port 154 and injection  
26 port 184) through either the circulating port 154 or  
27 the injection port 184 until the pressure of the  
28 fluid or gas reaches a relatively high fixed  
29 pressure. A pressure sensor (not shown), which is  
30 preferably a digital pressure sensor, is provided in  
31 either the circulating port 154 or the injection  
32 port 184 lines and the output of the pressure sensor

1 is preferably coupled to a computer control system  
2 that is recording the whole activity of the rig 100;  
3 the computer control system typically being located  
4 in the rig cabin 31. The computer control system  
5 (not shown) monitors the output of the pressure  
6 sensor, such that if the output of the pressure  
7 sensor starts to fall then the integrity of the pipe  
8 joint between the lower pipe 17C and the upper pipe  
9 17B is questionable. Such a questionable pipe joint  
10 connection could be due to a number of factors such  
11 as, but not limited to:-

12

13 1) wear and tear of the joint;

14

15 2) contamination within the screw thread  
16 connections of the joint;

17

18 3) insufficient torque being applied to the joint;  
19 and/or

20

21 4) excessive jawing or washout passing through the  
22 joint on previous trips of the joint into a  
23 borehole.

24

25 A second embodiment of a continuous circulating  
26 apparatus 160 is shown in schematic form in Fig. 26  
27 and comprises an upper seal 162, which may be in the  
28 form of a shaffer sealing element 162, similar to  
29 that shown in Fig. 19, a lower seal 164, again in  
30 the form of a shaffer sealing element and a plate  
31 valve 166, similar to that shown in Fig. 19. This  
32 embodiment is termed a stripper design 160. With

1 regard to the stripper design 160, it should be  
2 noted that the upper seal may alternatively be a  
3 rubber pack off element 162 in the form of a rubber  
4 ring 162. This provides a friction seal with  
5 respect to the outside surface of the pipe 17 or  
6 pipe joint and does not require to be actuated. The  
7 inner diameter of the rubber ring 162 is slightly  
8 less than the outer diameter of the pipe 17, and the  
9 rubber ring 162 is elastic such that it can deform  
10 to allow the passage of joints therethrough. The  
11 lower seal element 164 of the stripper design may  
12 have a similar rubber ring 164.

13

14 A third embodiment of a continuous circulating  
15 apparatus 170 is shown in Figs. 27 and 28 and  
16 comprises an upper seal 172 in the form of a pair of  
17 rams 172 similar to the rams 134 shown in Fig. 19, a  
18 lower seal 174 in the form of rams 174, similar to  
19 the rams 134 shown in Fig. 19, and a centre valve  
20 176 in the form of a pair of full bore sealing rams  
21 176. This third embodiment 170 is termed a ram  
22 design 170.

23

24 A method of operating the continuous circulating  
25 system will now be described.

26

27 For drilling operations, the lower end of a kelly  
28 hose 180 is attached to the upper end of the next  
29 drill pipe 17 to be made up into the drill string,  
30 with the upper end of the kelly hose 180 being  
31 coupled to the pipe handler fluid swivel 13. A  
32 drilling fluid supply conduit 182 is coupled to the

1       outer end of the goose neck pipe 18. Referring to  
2       Fig. 9a, at this point in the circulation system  
3       cycle, no drilling fluid is circulated through the  
4       goose neck 18, and the relative locations of the  
5       lower drill pipe 17c and upper drill pipe 17b within  
6       the snubbing unit 20 is shown in schematic form in  
7       Fig. 24 at this point. Valve  $V_3$ , which is located  
8       between the kelly hose 180 and the fluid supply  
9       conduit 182, is shown as closed. At this point,  
10      middle full bore valve, in the form of plate valve  
11      136 is shown as being closed, in that one of the  
12      sealing rings 152 is concentric with the  
13      longitudinal axis of the drill pipe 17c. Lower valve  
14      134 is closed around the outer surface of the upper  
15      end of drill pipe 17c, and injection port 184 is  
16      closed by means of valve  $V_2$ . Valve  $V_4$  is also closed  
17      and which is located between the kelly hose 180 and  
18      a bleed off line 186. Valves  $V_5$  and  $V_1$  are located  
19      between the circulating port 154 and the fluid  
20      supply conduit 182, and at this point,  $V_5$  and  $V_1$  are  
21      both open, and hence drilling fluid is being  
22      supplied through circulating port 154 and into the  
23      inner bore of the snubbing unit 20 and hence inner  
24      bore of the drill pipe 17c.

25  
26       It should also be noted that the snubbing unit 20 is  
27       provided with another slip system 190, in the form  
28       of upper slips 190, and which will normally only be  
29       utilised during a continuous circulating operation.  
30       The upper slips 190 (not shown in Fig. 17(a) but  
31       shown in schematic form in Figs. 24 and 25, and  
32       shown in a preferred form in Figs. 29, 30 and 31)

1 are mounted to the upper end of a feeder plate 192  
2 of the snubbing unit 20 by means of an arrangement  
3 of hydraulic jacking cylinders 194, and in a  
4 preferred embodiment, there are four such hydraulic  
5 jacking cylinders 194. The upper slips 190 are  
6 operable to firmly grip the drill pipe 17b as it is  
7 being inserted into the snubbing unit 20, such that  
8 the upper slips 190 provide support to the drill  
9 pipe 17b, and the hydraulic jacking cylinders 194  
10 are actuated to firmly lower or feed the drill pipe  
11 17b into the snubbing unit 20.

12

13 The next stage of operation is shown in Fig. 25, and  
14 which shows that the middle plate valve 136 has been  
15 rotated such that an aperture 150 is co-axial with  
16 the longitudinal axis of the drill pipes 17.  
17 Simultaneously, the upper seal 132 is closed around  
18 the upper pipe 17b, and valve  $V_3$  is opened. This  
19 flushes fluid into the drill pipe 17b and hence  
20 equalises the pressure above the plate valve 136,  
21 with the pressure below the plate valve 136, since  
22 valves  $V_5$  and  $V_1$  are still open.

23

24 The upper slips 190 remain actuated to firmly grip,  
25 and hence support, the drill pipe 17b against the  
26 force of the pressure which would otherwise force  
27 the drill pipe 17b upwards and out of the snubbing  
28 unit 20.

29

30 The plate valve 136 is then rotated to the position  
31 shown in Fig. 25 such that one of the apertures 150

1 is concentric with the longitudinal axis of the  
2 drill pipe 17. Valve V<sub>1</sub> is then closed.

3

4 Downward movement of the upper pipe 17b is again  
5 commenced as previously described (i.e. by a  
6 combination of downward movement of the wire pulley  
7 10b and also downward movement of the hydraulic  
8 jacking cylinders 194) until it comes into close  
9 proximity with the upper end of lower pipe 17c.

10 Valve V<sub>2</sub> is then opened and a suitable fluid is  
11 supplied into the injection port 184 via the now  
12 open V<sub>2</sub>, in order to flush the threads of the two  
13 pipes. Hence, the upper tong 108 and the lower tong  
14 or rotary back up 109 are operated to grip the two  
15 pipes 17b, 17c and the actuation of the upper slips  
16 190 upon the drill pipe 17b is released.

17 Thereafter, the upper tong 108 and the lower  
18 tong/rotary back up 109 are operated to make up the  
19 two pipes 17b, 17c.

20

21 The drill string 17 continues its downward movement  
22 by operation of the hydraulic jacking cylinders 122,  
23 travelling slips 114 and fixed slips 124 until such  
24 a time that the upper end of the pipe 17b is at the  
25 thread engagement height; that is the location of  
26 pipe 17c as shown in Fig. 24. The kelly valve is  
27 then backed off the upper end of pipe 17b and is  
28 pulled upwardly by the counterbalance winch and/or  
29 the upper slips 190 and hydraulic jacking cylinders  
30 194. It should be noted that upper seal 132 is  
31 still sealing around the kelly valve. Once the  
32 kelly valve has passed upwards through the aperture

1 150, the middle plate valve 136 is closed. Valve V<sub>4</sub>  
2 is then opened to bleed off pressure, and V<sub>3</sub> is  
3 closed and V<sub>5</sub> is opened. The upper seal element 132  
4 can then be opened and the next pipe joint can be  
5 introduced into the snubbing unit 20. The method is  
6 repeated for as many joints as required, and hence  
7 continuous circulation of drilling fluid through the  
8 drill string is achieved.

9

10 Figs. 29 to 31 show a preferred form of a slip  
11 mechanism 200; it should be noted that the slip  
12 mechanism 200 is preferably suitable for use as the  
13 fixed/stationary slips 124 and/or travelling slips  
14 114 and/or upper slips 190.

15

16 The slip mechanism 200 can also be referred to as a  
17 snubbing slip mechanism 200. The slip mechanism 200  
18 comprises a slip bowl 202 or slip housing 202 which  
19 is provided with at least one, and preferably four,  
20 hydraulic jacking cylinders 204 which extend  
21 vertically upwardly from the base of the slip  
22 housing 202. Four snubbing slips 206 are provided  
23 within the slip housing 202 where the width of each  
24 snubbing slip 206 circumscribes no greater than 90°  
25 of a circle. The innermost faces of each of the  
26 snubbing slips 206 have a common curvature such that  
27 when they are in the closed configuration as shown  
28 in Fig. 30, they 206 come together to form an inner  
29 bore and are provided with a suitably grippable  
30 surface such that they 206 are capable of securely  
31 gripping the outer surface of the drill pipe 17 and  
32 can thus support the weight of the drill string.

1 The inner surface of the slip housing 202 is tapered  
2 outwardly from the base of the slip housing 202 to  
3 the uppermost portion of the slip housing 202 and  
4 four longitudinally extending slots (not shown) are  
5 formed equi-distantly around the inner surface of  
6 the slip housing 202. A longitudinally extending  
7 dovetail shaped key (not shown) is provided on the  
8 outer surface of each snubbing slip 206 such that  
9 the dovetail shaped key engages in the respective  
10 slot of the slip housing 202. The upper end of the  
11 hydraulic jacking cylinders 204 are suitably coupled  
12 to each snubbing slip 206 such that actuation of the  
13 hydraulic jacking cylinders 204 moves the cylinders  
14 204 from their home (non-stroked) configuration  
15 shown in Fig. 30 to the fully stroked configuration  
16 shown in Fig. 29; in this manner the snubbing slips  
17 206 can be moved from the closed (and pipe gripping)  
18 configuration shown in Fig. 30 to the open (and non-  
19 pipe gripping) configuration shown in Fig. 29.  
20

21 It should be noted that conventionally, particularly  
22 when tubing such as casing and liner tubing (which  
23 has a flush outer surface along its length) is being  
24 passed through a set of slips, that a safety  
25 mechanism is used. This conventional safety  
26 mechanism comprises a manual clamp which is set  
27 around the outer surface of the tubing and which  
28 must be put on manually by an operator such as a  
29 roughneck. This manually applied clamp is arranged  
30 to act as a safety feature such that if the snubbing  
31 slips 206 lose their grip on the smooth outer  
32 surface of the casing/liner string then the manually

1 applied clamp will collide against the upper surface  
2 of the snubbing slips, thus forcing them further  
3 down the tapered surface and thereby increasing the  
4 grip being applied by the snubbing slips to the  
5 outer surface of the casing. However, this  
6 conventional clamp arrangement is dangerous to apply  
7 and also time consuming.

8

9 In accordance with the present invention a safety  
10 slip 208 is mounted to the upper end of each  
11 snubbing slip 206 by means of a biasing mechanism  
12 such as a set of coiled springs 210; however, those  
13 skilled in the art will appreciate that a different  
14 type of biasing mechanism could be used, such as a  
15 leaf spring or rubber/neoprene element (not shown)  
16 or a lever arrangement as shown in the second  
17 embodiment of Figs. 32 to 34. The coiled springs  
18 210 are arranged to naturally bias the safety slips  
19 208 away from the snubbing slips 206. When the  
20 snubbing slips 206 are in the closed configuration  
21 as shown in Fig. 30, they are gripping the casing  
22 string or drill string 17 and the safety slips 208  
23 are also gripping the outer surface of the string  
24 since the rear end or outermost end of each safety  
25 slip 208 abuts against a safety slip stop 212 which  
26 is conveniently mounted in a suitable manner to the  
27 upper end of the snubbing slip 206. Even more  
28 advantageously, the safety slip 208 is provided with  
29 a moveable safety slip front 214, where the safety  
30 slip front 214 is mounted to the safety slip back  
31 208 by means of a dovetail shaped key (not shown)

1 and slot (not shown) arrangement provided on a  
2 tapered surface, as shown in Fig. 31.

3

4 Accordingly, with the safety slip front 214 gripping  
5 the casing string, if the casing string begins to  
6 slip through the snubbing slips 206 when they are in  
7 the closed configuration, the safety slip front 214  
8 and then the safety slip back 208 will travel  
9 downwardly with the casing string against the  
10 biasing action of the coiled springs 210 until the  
11 lower face of the front 214 and back 208 collide  
12 with the upper face of the snubbing slips 206 across  
13 the full cross-sectional area of the upper face of  
14 the snubbing slips 206 (which are greater in cross-  
15 sectional area than the lower face of the snubbing  
16 slips 206). Accordingly, the aforementioned  
17 collision causes the snubbing slips 206 to move  
18 downwardly to grip the tubing string even more.

19 When the tubing string or drill string is ready to  
20 intentionally move through the slip mechanism 200,  
21 the cylinders 204 are actuated to stroke outwardly  
22 from the closed configuration of Fig. 30 to the open  
23 configuration of Fig. 29. In this manner, the  
24 snubbing slips 206 and safety slips 208, 214 are  
25 moved not only upwardly but outwardly away from the  
26 tubing/drill string 17, and the safety slips 208,  
27 214 are moved upwardly away from the snubbing slip  
28 206 by the biasing mechanism 210, such that they  
29 208, 214 return to their 208, 214 starting (spaced)  
30 configuration.

31

1 Accordingly, the embodiment of the slip mechanism  
2 provides an automatic safety slip 208, 214 device  
3 that does not require manual intervention.

4

5 Figs. 32, 33 and 34 show an alternative arrangement  
6 of the safety slips 208, 214 where the safety slips  
7 208, 214 move in an arc via a hinge 218 and pivot  
8 219 into engagement and out of engagement with the  
9 tubing string or drill string 17, rather than in the  
10 vertical movement shown in the embodiment of Figs.  
11 29 and 30, where the arc movement is shown in Fig.  
12 33 by arrow 216. In addition, the hinge 218 that  
13 moves about the pivot 219, acts as a safety slip  
14 stop 218, 219.

15

16 The aforementioned apparatus provides distinct  
17 advantages over conventional work over and drilling  
18 units. For instance, it is capable of making or  
19 breaking connections while circulating and tripping  
20 pipe in or out of the well bore. Furthermore, it  
21 can replace a conventional rotary table and can be  
22 rigged up on almost any drilling rig, platform,  
23 drill ship or floater. For rig assist, the jacking  
24 slips are picked up like a joint of pipe and simply  
25 stabbed into the rotary table. The unit fits flush  
26 with the rig floor and allows for normal rig pipe  
27 handling to be used. In this scenario, there is  
28 minimal or no learning curve for the rig personnel  
29 to go through, and with there being no loose  
30 equipment above the rig floor 8 associated with this  
31 apparatus, the possibility of dropped objects has  
32 been eliminated.

1  
2      The unique articulating pipe handling arms 12 and  
3      power tong 108, 109 make up provides the apparatus  
4      100 with the ability to make tubular connections "on  
5      the fly" with a continual trip speed of over 60  
6      joints per hour being possible.

7

8      The apparatus 100 can be broken down into readily  
9      liveable components. Furthermore, the continuous  
10     circulation feature allows an operator to make and  
11     break connections without stopping circulation of  
12     fluid through the drill string. It is envisaged  
13     that the system will minimise collapse of boreholes  
14     and differential sticking without surging the  
15     borehole formation.

16

17     Modifications and improvements can be made to the  
18     embodiments herein described without departing from  
19     the scope of the invention.

1       **CLAIMS:-**

2

3       1. A tong apparatus comprising:-

4               an upper tong having a gripping device for  
5               gripping a tubular, the upper tong further  
6               comprising a rotation mechanism to provide rotation  
7               to the gripping device to provide rotation to said  
8               tubular; and9               a lower tong having a gripping device for  
10               gripping a tubular, the lower tong further  
11               comprising a rotation mechanism to provide rotation  
12               to the gripping device to provide rotation to said  
13               tubular.

14

15       2. A tong apparatus according to claim 1, wherein  
16               a motive means is provided to actuate the respective  
17               rotation mechanism of the upper and lower tongs.

18

19       3. A tong apparatus according to either of claims  
20               1 or 2, wherein the lower tong further comprises a  
21               turntable bearing means which support ring gear of  
22               the gripping device.

23

24       4. A tong apparatus according to any preceding  
25               claim, wherein the lower tong further comprises a  
26               braking system which permits controlled release of  
27               residual torque of a string of tubulars.

28

29       5. A tong apparatus according to any preceding  
30               claim, further comprising a travelling slip  
31               mechanism which is capable of engaging at least a  
32               portion of the outer circumference of a tubular, and  
33               preferably, the travelling slip is capable of being

1       rotated by means of a rotary bearing assembly  
2       mechanism.

3

4       6.    A tong apparatus according to claim 5, wherein  
5       the travelling slip mechanism is provided with a  
6       vertical movement mechanism which can be actuated to  
7       move the travelling slip and the engaged string of  
8       tubulars in one or both vertical directions.

9

10      7.    A method of providing rotation to at least one  
11       tubular, the method comprising:-

12           providing an upper tong having a gripping  
13       device for gripping a tubular, the upper tong  
14       further comprising a rotation mechanism to provide  
15       rotation to the gripping device;

16           providing a lower tong having a gripping device  
17       for gripping a tubular, the lower tong further  
18       comprising a rotation mechanism to provide rotation  
19       to the gripping device; and

20           operating at least the rotation mechanism of  
21       the upper tong to provide rotation to said tubular.

22

23      8.    A method according to claim 7, further  
24       comprising operating the rotation mechanism of the  
25       lower tong to provide rotation to said tubular.

26

27      9.    An apparatus for circulating fluid through a  
28       tubular string, the string comprising at least one  
29       tubular, the apparatus comprising:-

1           a first fluid conduit for supplying fluid to  
2        the bore of an upper tubular to be made up into or  
3        broken out from the tubular string; and  
4           a second fluid conduit for supplying fluid to the  
5        bore of the tubular string.

6

7        10. An apparatus according to claim 9, wherein the  
8        first fluid conduit is releasably engageable with an  
9        upper end of the upper tubular.

10

11       11. An apparatus according to either of claims 9 or  
12      10, wherein the first fluid conduit is provided with  
13      a valve mechanism which is operable to permit the  
14      flow of fluid into and/or deny the flow of fluid  
15      into the first fluid conduit and/or upper end of the  
16      tubular.

17

18       12. An apparatus according to any of claims 9 to  
19      11, wherein one end of the second fluid conduit is  
20      in fluid communication with a chamber, and the  
21      second fluid conduit is provided with a valve  
22      mechanism which is operable to permit the flow of  
23      fluid into, or deny the flow of fluid into, the  
24      second fluid conduit and/or the chamber.

25

26       13. An apparatus according to claim 12, wherein  
27      the chamber is adapted to permit a tubular to be  
28      made up into, or broken out from, a tubular string.

29

30       14. An apparatus according to either of claims 12

1       or 13, wherein the chamber comprises a bore which is  
2       vertically arranged to be coincident with the  
3       longitudinal axis of the mouth of a borehole.

4

5       15. An apparatus according to claim 14, wherein  
6       the chamber comprises an upper port into which the  
7       said tubular can be inserted into or removed from  
8       the chamber.

9

10      16. An apparatus according to either of claims 14  
11      or 15, further comprising a valve mechanism actuatable  
12      to seal the bore of the chamber at a location below  
13      the upper port.

14

15      17. An apparatus according to claim 16, further  
16      comprising an upper seal located above the said  
17      location, and where the upper seal is arranged to  
18      seal around at least a portion of the circumference  
19      of the said tubular.

20

21      18. An apparatus according to either of claims 15  
22      or 16, further comprising a lower seal located below  
23      the said location, and where the lower seal is  
24      arranged to seal around at least a portion of the  
25      circumference of the tubular string.

26

27      19. An apparatus according to claim 12 further  
28      comprising a valve system comprising one or more  
29      further valves is provided to control the supply of  
30      fluid to the first fluid conduit valve mechanism and  
31      second fluid conduit valve mechanism.

1

2 20. A method of circulating fluid through a tubular  
3 string, the string comprising at least one tubular,  
4 the method comprising:-

5 providing a first fluid conduit for supplying  
6 fluid to the bore of an upper tubular to be made up  
7 into or broken out from the tubular string; and  
8 providing a second fluid conduit for supplying fluid  
9 to the bore of the tubular string.

10

11 21. The method according to claim 20, comprising  
12 the further steps of inserting the lower end of the  
13 upper tubular into an upper port, where a valve  
14 mechanism denies the flow of fluid into the first  
15 fluid conduit.

16

17 22. The method according to claim 21, comprising  
18 the further steps of operating the valve mechanism  
19 to permit the flow of fluid into the first fluid  
20 conduit and upper end of the tubular.

21

22 23. An apparatus for providing a seal with a  
23 tubular to be made up in to or broken out from a  
24 tubular string, the tubular string comprising at  
25 least one tubular, the apparatus comprising:-

26 an upper seal device for sealing about a  
27 portion of the outer circumference of the said  
28 tubular to be made up onto or broken out from the  
29 string;

30 a lower seal device for sealing about a portion  
31 of the outer circumference of the string; and

1 the upper seal device comprising an elastomeric ring  
2 which is adapted to have an inner diameter  
3 substantially the same as the outer diameter of at  
4 least a portion of the tubular.

5

6 24. Apparatus according to claim 23, wherein the  
7 the lower seal device also comprises an elastomeric  
8 ring which is adapted to have an inner diameter  
9 substantially the same as the outer diameter of at  
10 least a portion of tubular string.

11

12 25. A valve mechanism for providing a seal between  
13 two tubulars, the valve mechanism comprising:-

14 a plate member which is capable of rotation  
15 about an axis;

16 at least one bore formed through the plate  
17 member;

18 the plate member being capable of movement  
19 between a first configuration in which a portion of  
20 the plate member obturates the longitudinal axis of  
21 at least one of the tubulars; and

22 a second configuration in which the bore is  
23 concentric with the longitudinal axis of at least  
24 one of the tubulars.

25

26 26. A valve mechanism according to claim 25,  
27 wherein the plate member is capable of being rotated  
28 between a first configuration from which a portion  
29 of the plate member obturates the longitudinal axis  
30 of both of the tubulars, and a second configuration  
31 in which the bore is concentric with the

1       longitudinal axis of both of the tubulars, both of  
2       the tubulars being concentric with one another.

3

4       27. A valve mechanism according to either of claims  
5       25 or 26, wherein the plate member is circular and  
6       is arranged within a cylindrical chamber, such that  
7       the radius of the plate member is perpendicular to  
8       the longitudinal axis of both tubulars.

9

10      28. A valve mechanism according to claim 27,  
11       wherein the centre axis of the plate member is off-  
12       centre with respect to the longitudinal axis of both  
13       tubulars.

14

15      29. A method of providing a seal between two  
16       tubulars, the method comprising:-

17            providing a plate member which is capable of  
18       rotation about an axis;

19            the plate member having at least one bore;  
20            wherein the plate member is capable of being  
21       rotated between a first configuration in which a  
22       portion of the plate member obturates the  
23       longitudinal axis of at least one of the tubulars  
24       and a second configuration in which the bore is  
25       concentric with the longitudinal axis of at least  
26       one of the tubulars.

27

28      30. An apparatus to prevent at least one tubular  
29       slipping therein, the apparatus comprising a first  
30       arrangement of grips adapted to grip at least one of  
31       the tubular(s), and a second arrangement of grips

1       adapted to grip the said tubular(s), characterised  
2       in that the first and second arrangements of grips  
3       are coupled to one another.

4

5       31. An apparatus according to claim 30, wherein the  
6       first and second arrangements of grips are coupled  
7       to one another by a biasing mechanism.

8

9       32. An apparatus according to claim 31, wherein  
10      the biasing mechanism is arranged to bias the first  
11      and second arrangements of grips away from one  
12      another.

13

14      33. An apparatus according to any of claims 30 to  
15      32, wherein at least one of each of the first and  
16      second arrangements of grips comprise first and  
17      second portions, wherein the first portion is  
18      coupled to the second portion by a tapered surface,  
19      and a moveable locking mechanism, such that the  
20      first portion is capable of moving with respect to  
21      the second portion along the tapered surface.

22

23      34. An apparatus according to any of claims 30 to  
24      33, wherein the first arrangements of grips are  
25      located vertically below the second arrangements of  
26      grips and the first arrangements of grips comprise a  
27      relatively large surface area for gripping the  
28      tubular.

29

30      35. An apparatus according to claim 34, wherein the

1 second arrangement of grips comprise a relatively  
2 smaller surface area for gripping the tubular.

3

4 36. An apparatus according to any of claims 30 to  
5 35, wherein a lower face of the second arrangement  
6 of grips is coupled to an upper face of the first  
7 arrangement of grips, and the upper face of the  
8 first arrangement of grips is of a larger surface  
9 area than a lower face of the first arrangement of  
10 grips.

11

12 37. An apparatus according to any of claims 30 to  
13 36, wherein the first arrangement of grips comprise  
14 a stop means for preventing movement of the second  
15 arrangement of grips in a direction radially away  
16 from the tubular being gripped.

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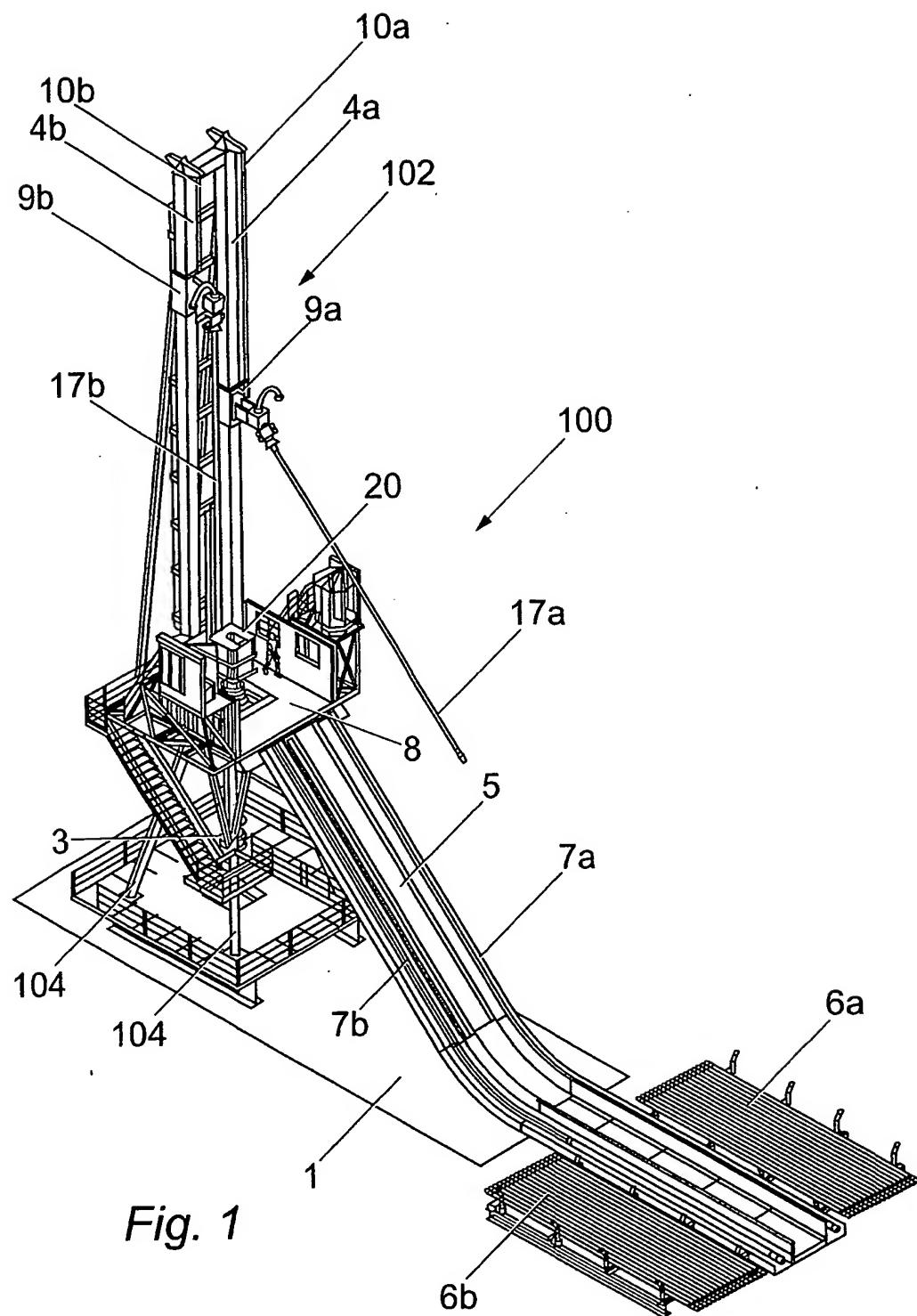
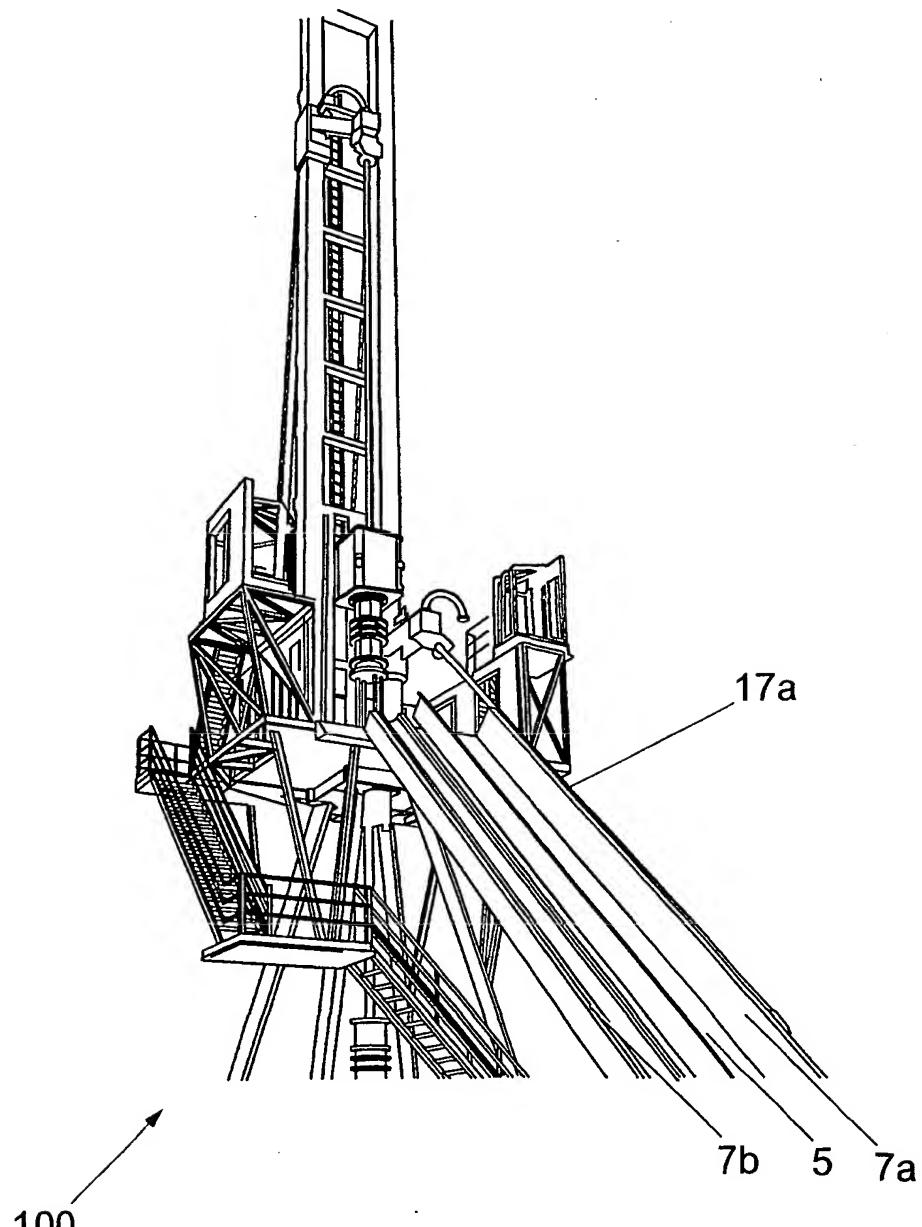


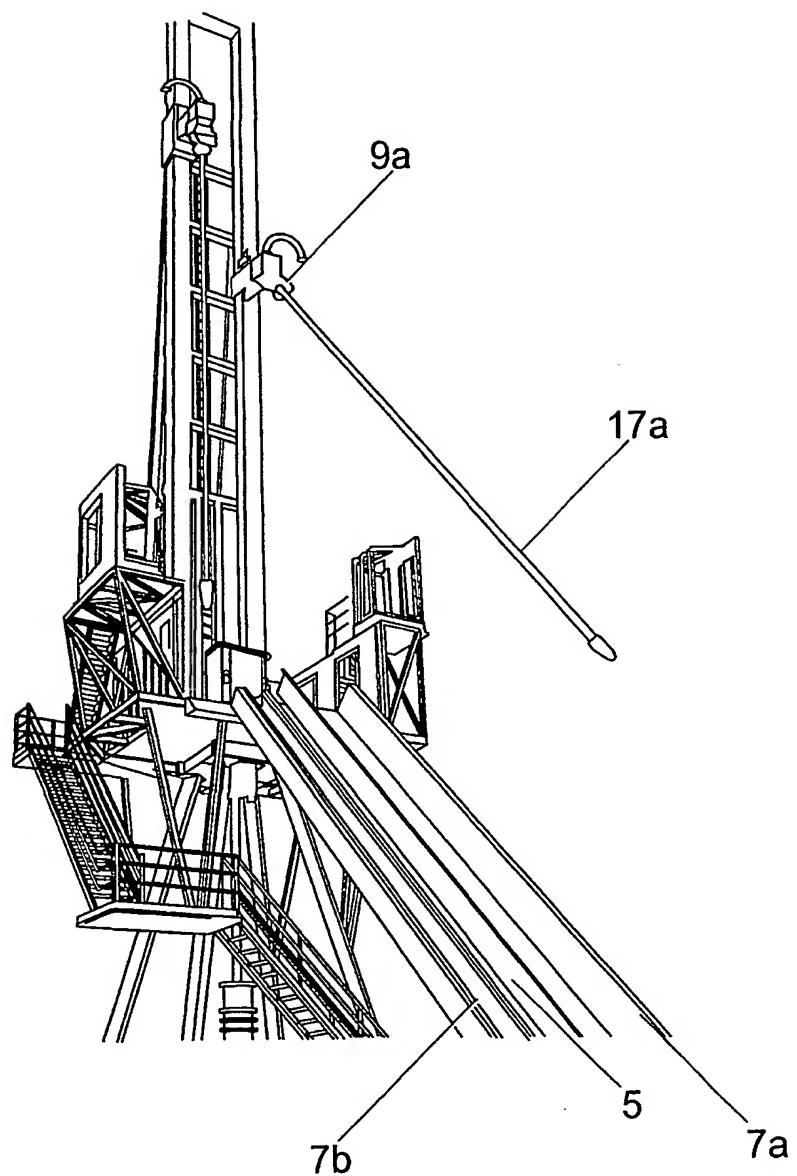
Fig. 1

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*Fig. 2*

3 / 32



*Fig. 3a*

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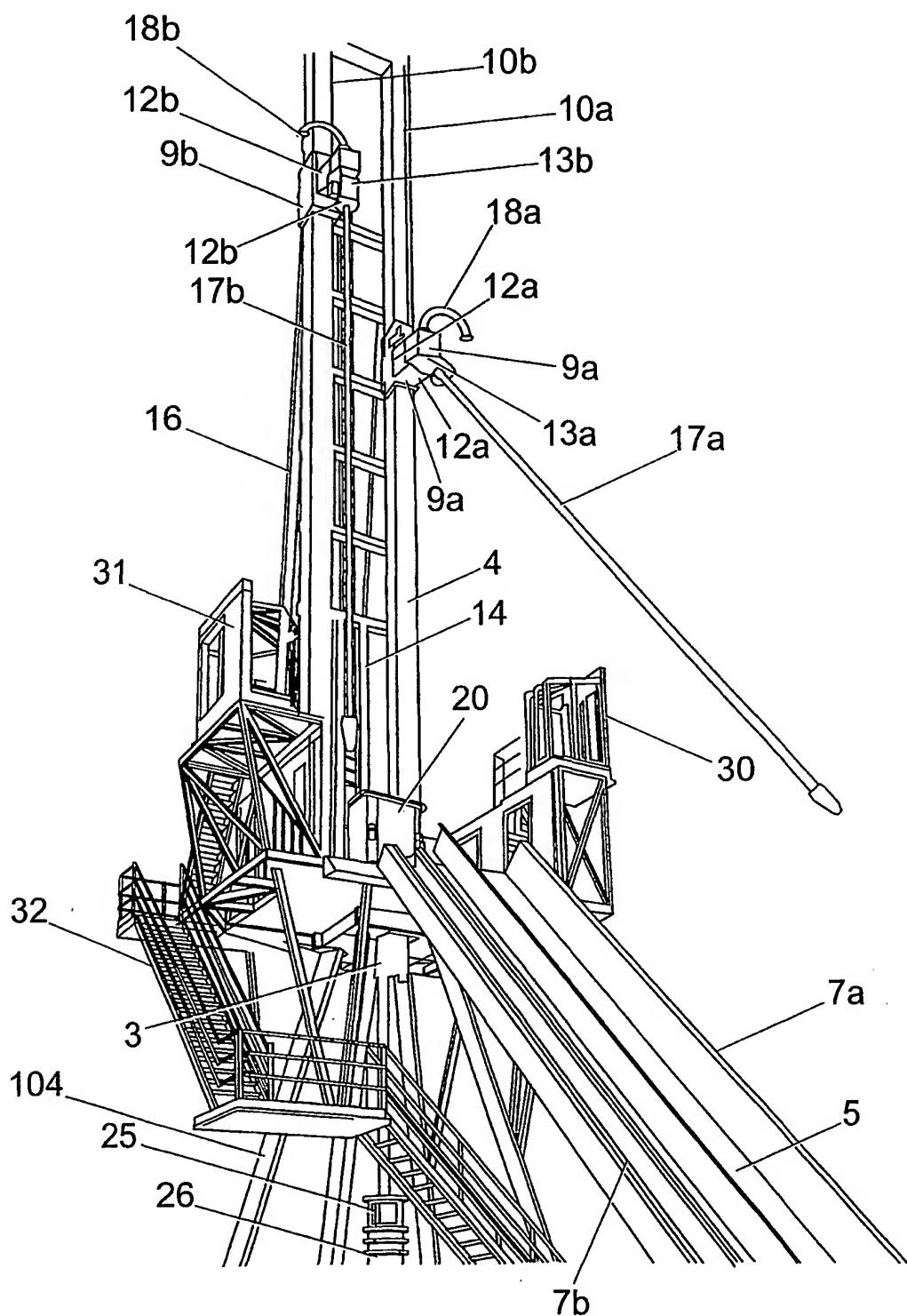


Fig. 3b

5 / 32

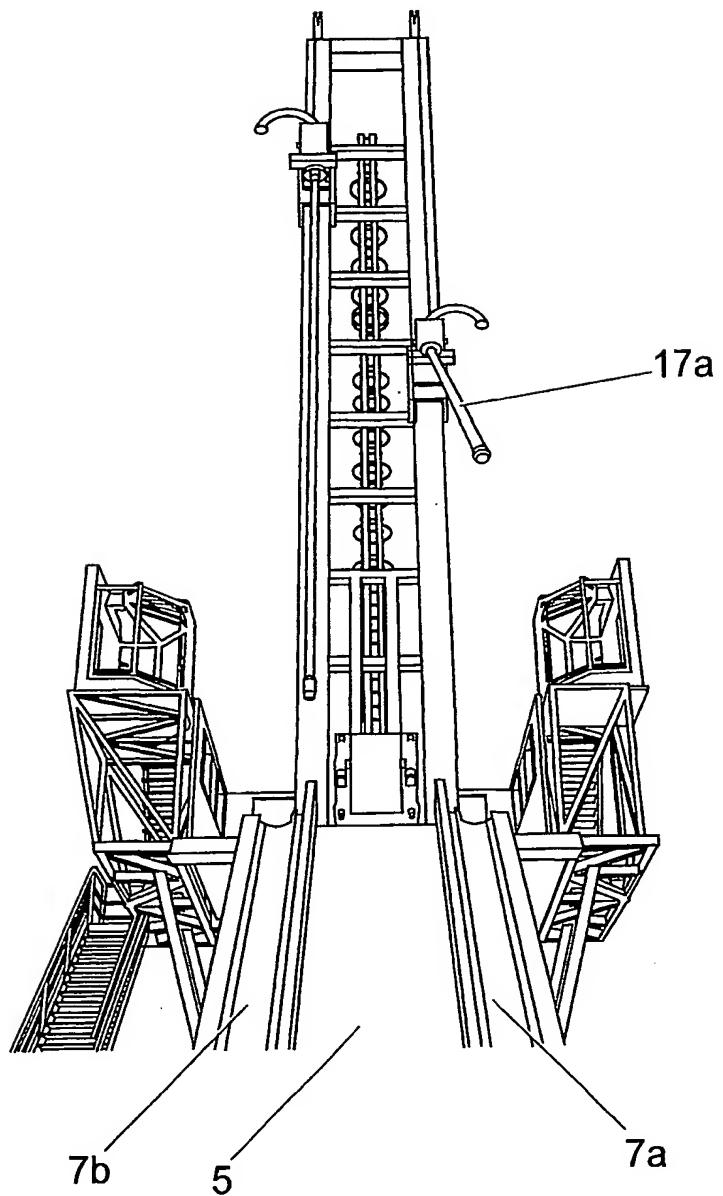
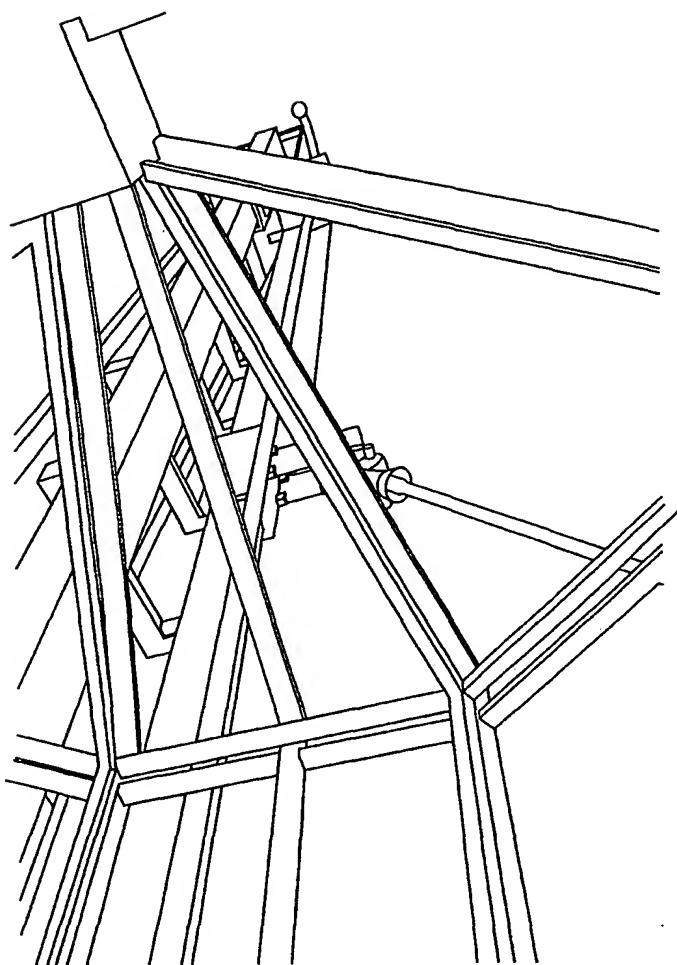


Fig. 4

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*Fig. 5*

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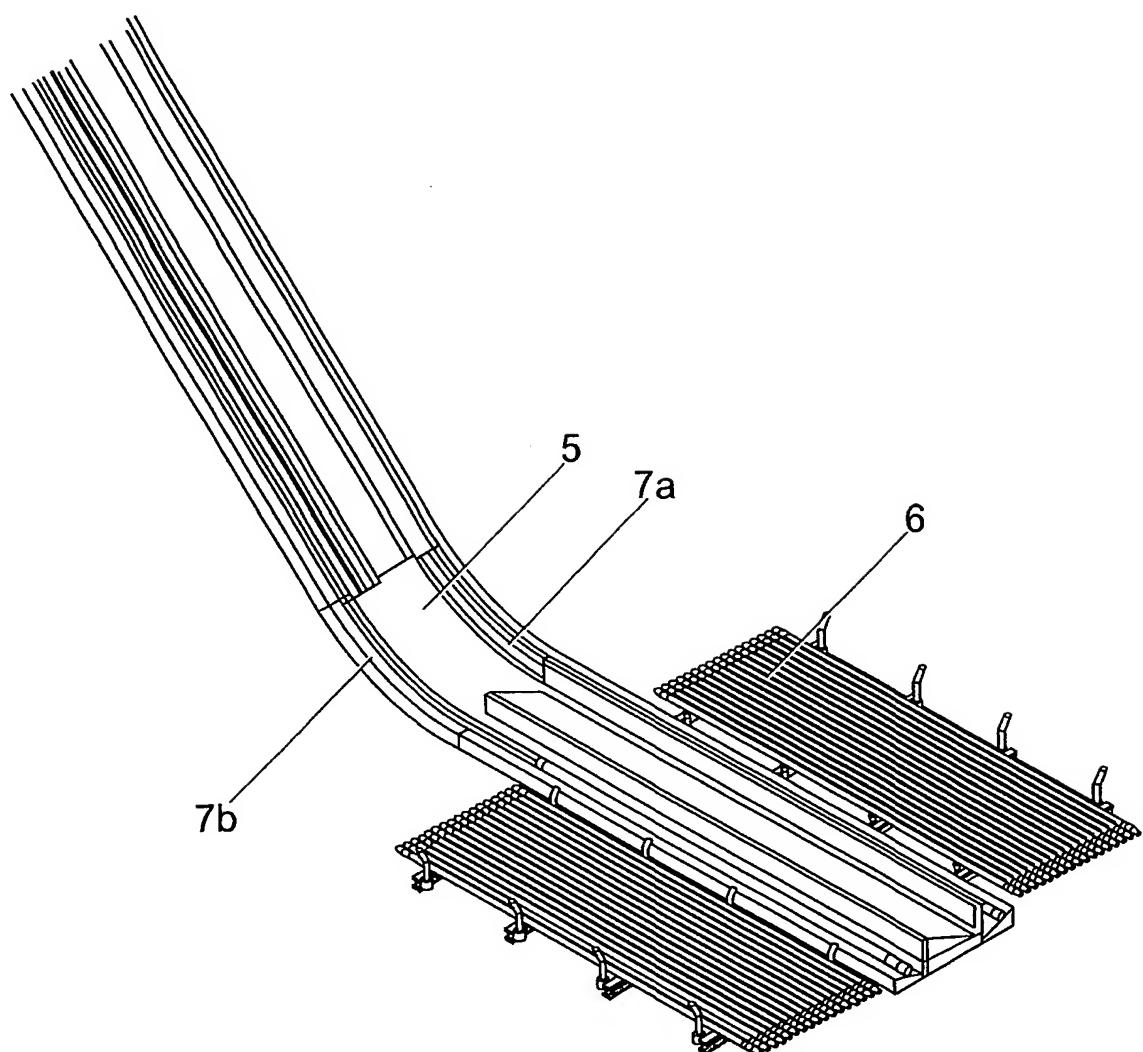


Fig. 6

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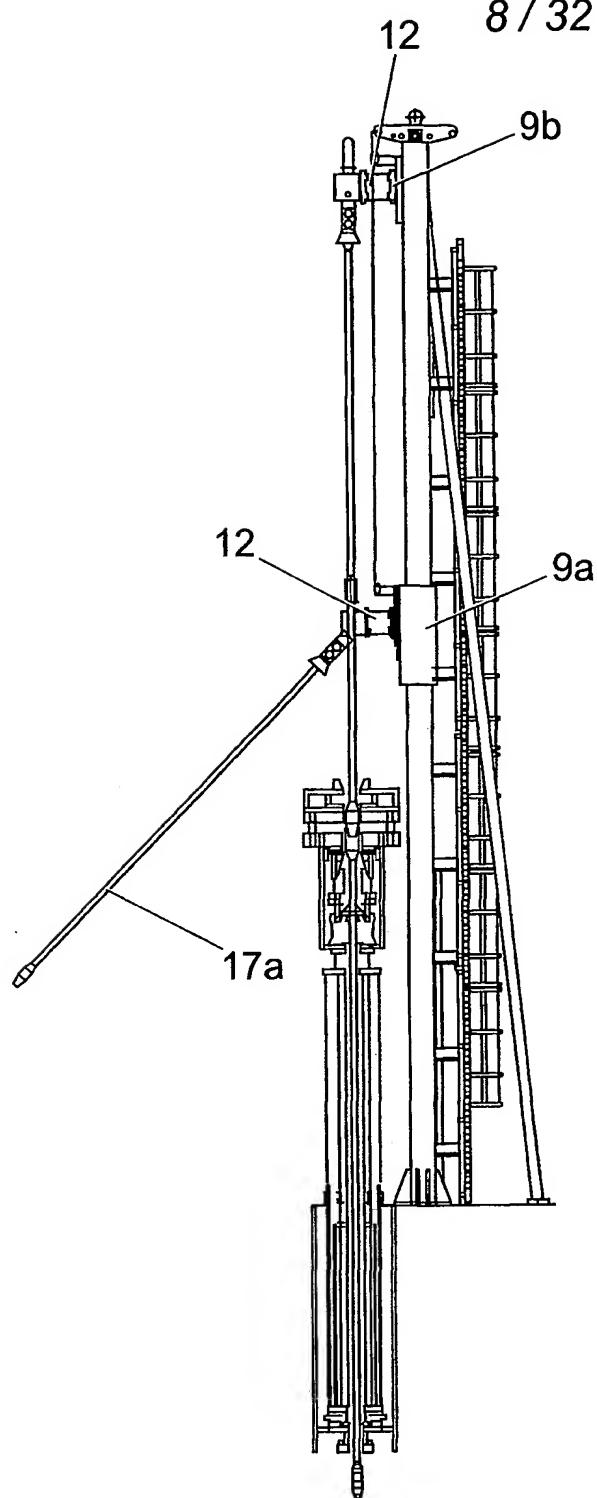
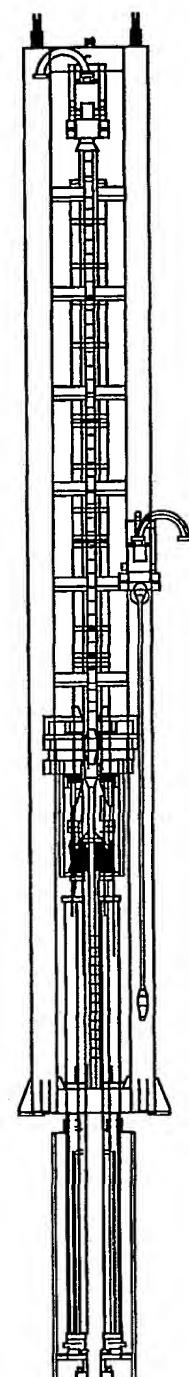


Fig. 7a

Fig. 7b



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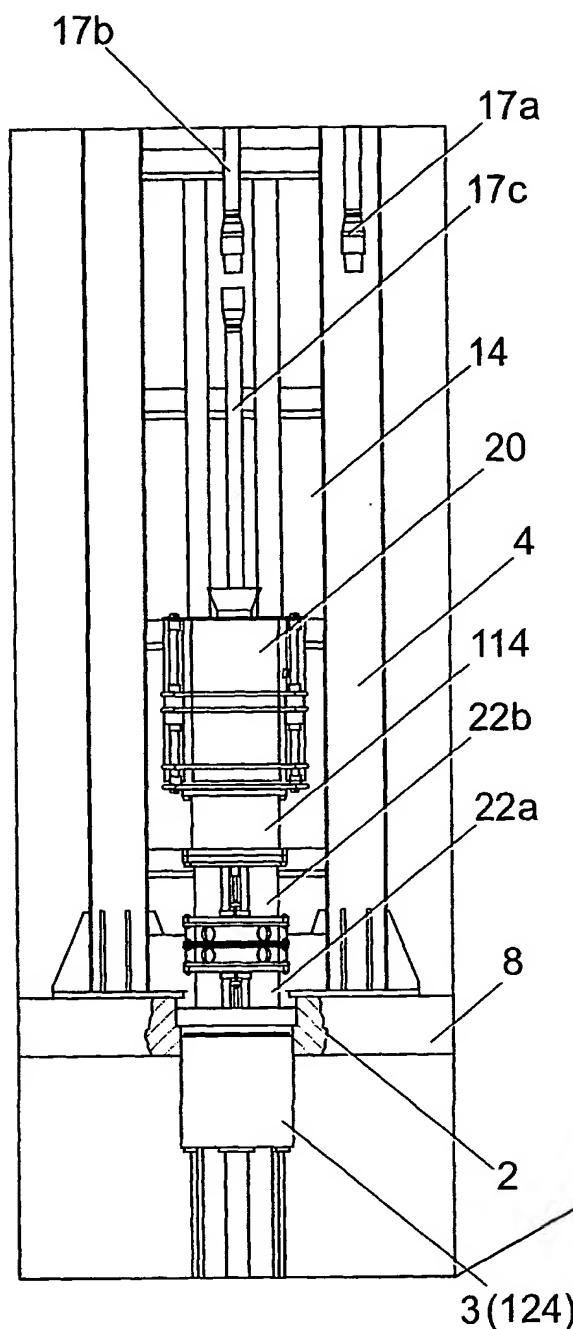


Fig. 8a

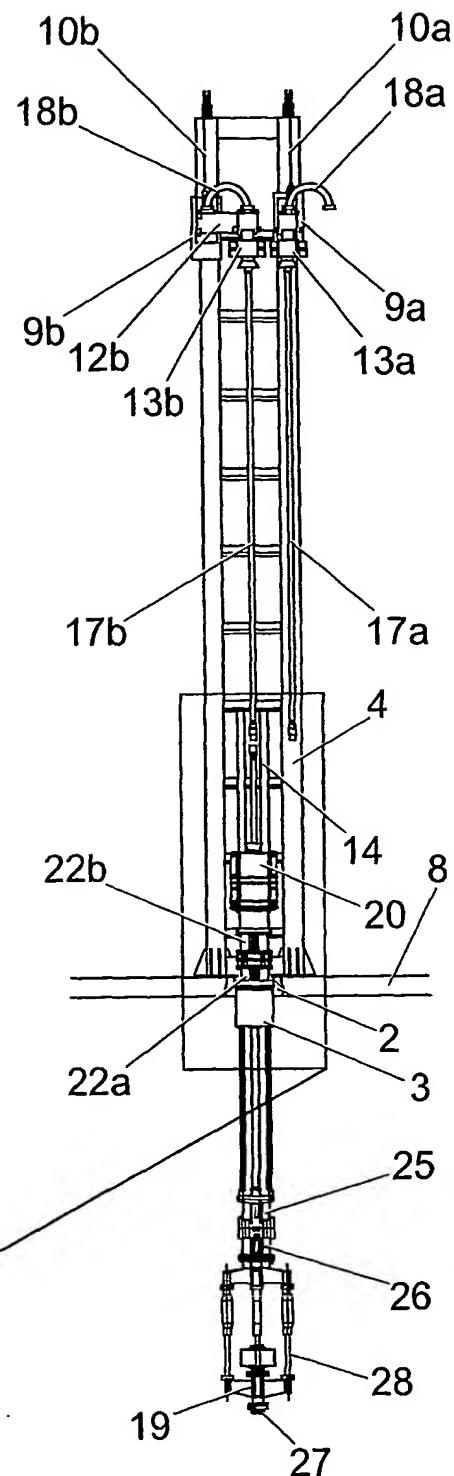


Fig. 8b

10 / 32

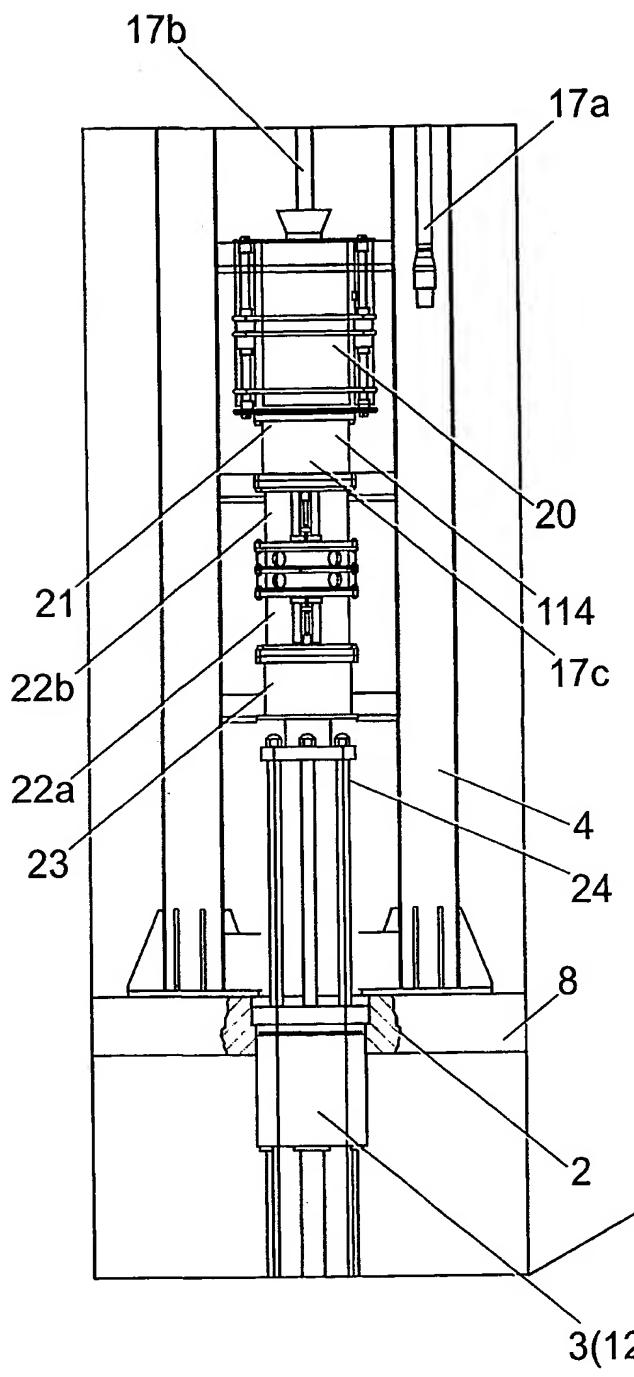


Fig. 9a

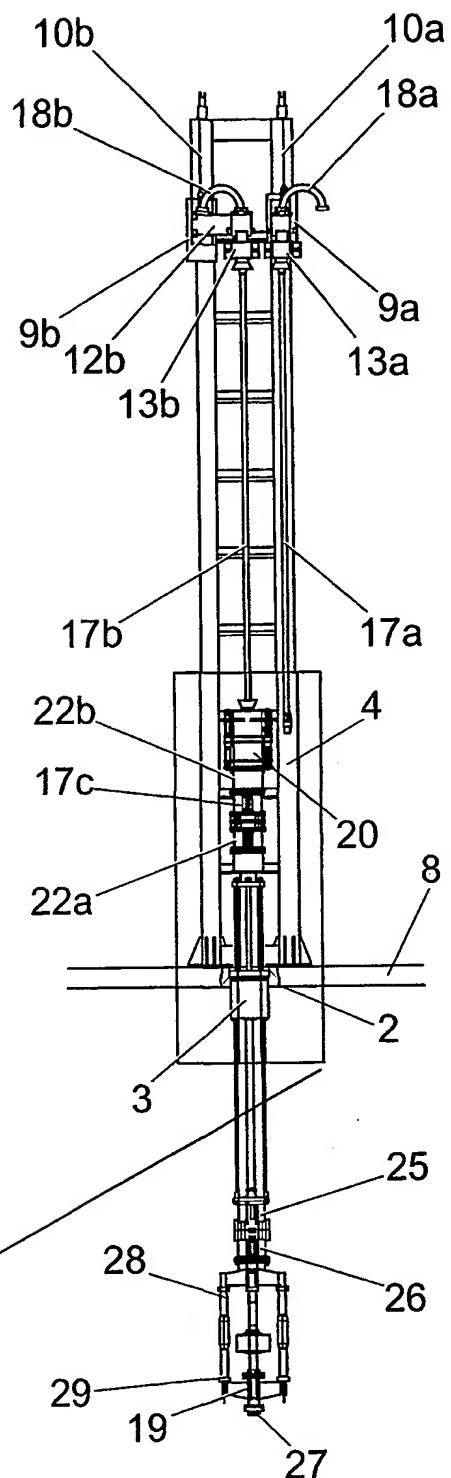


Fig. 9b

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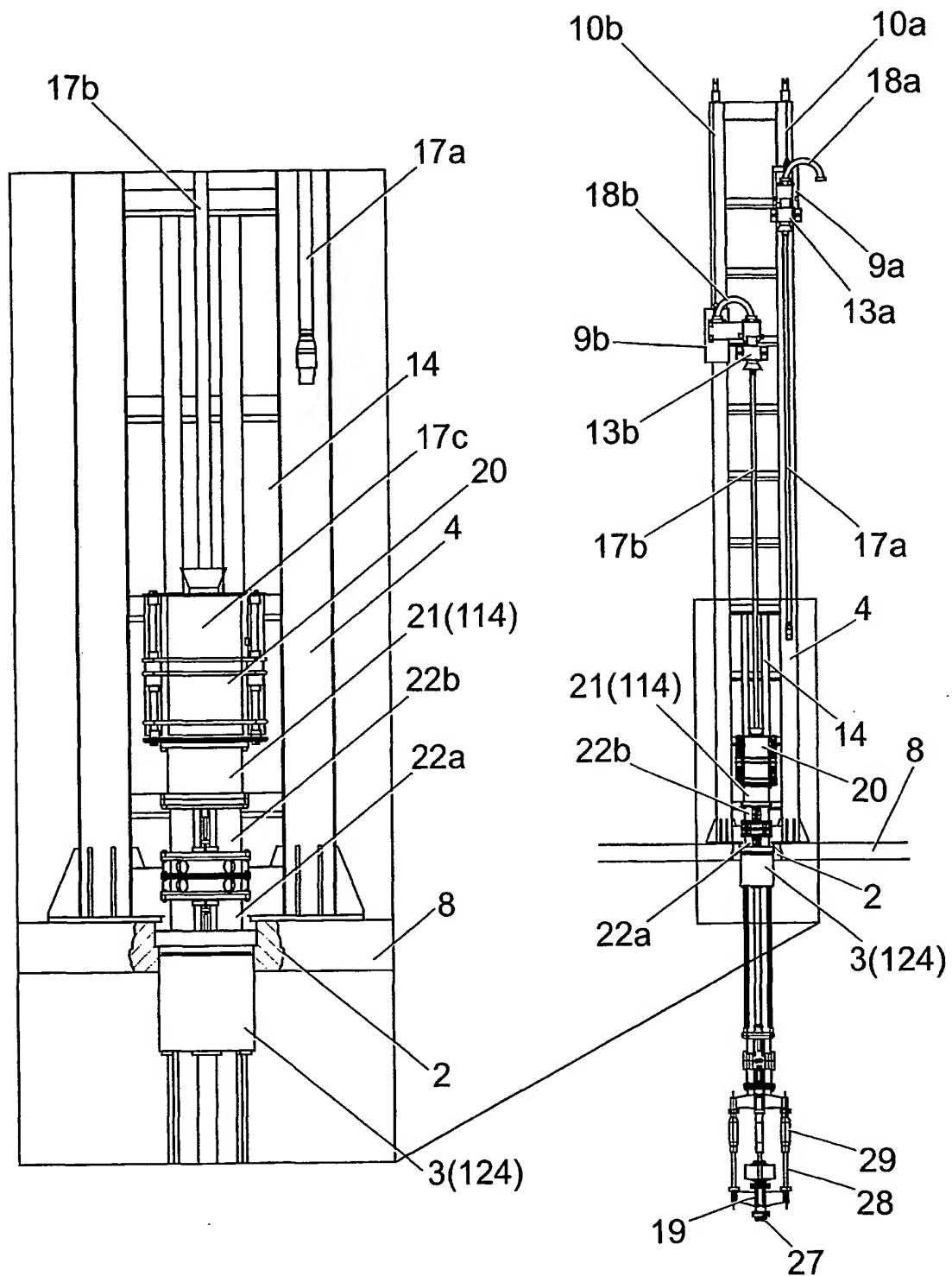


Fig. 10a

Fig. 10b

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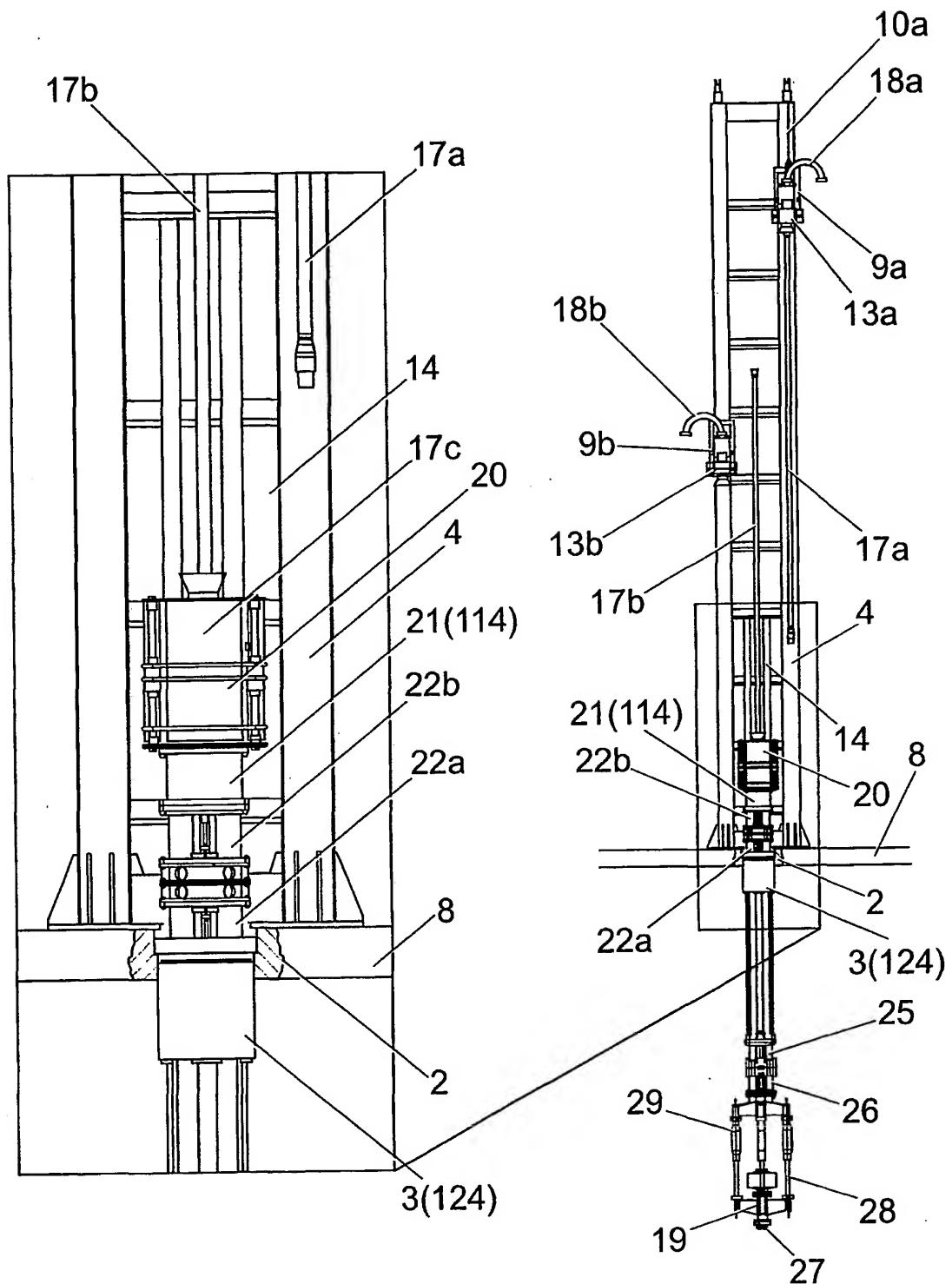


Fig. 11a

Fig. 11b

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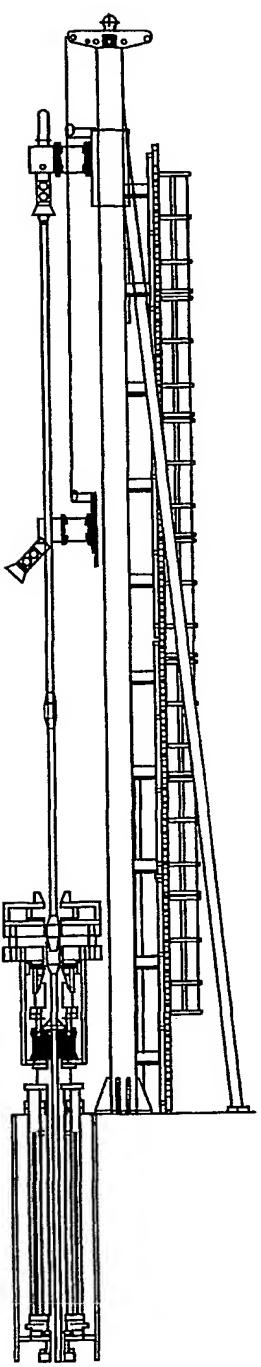


Fig. 12a

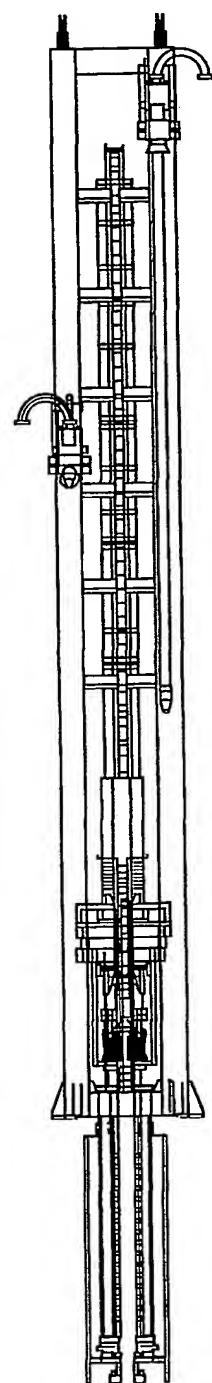


Fig. 12b

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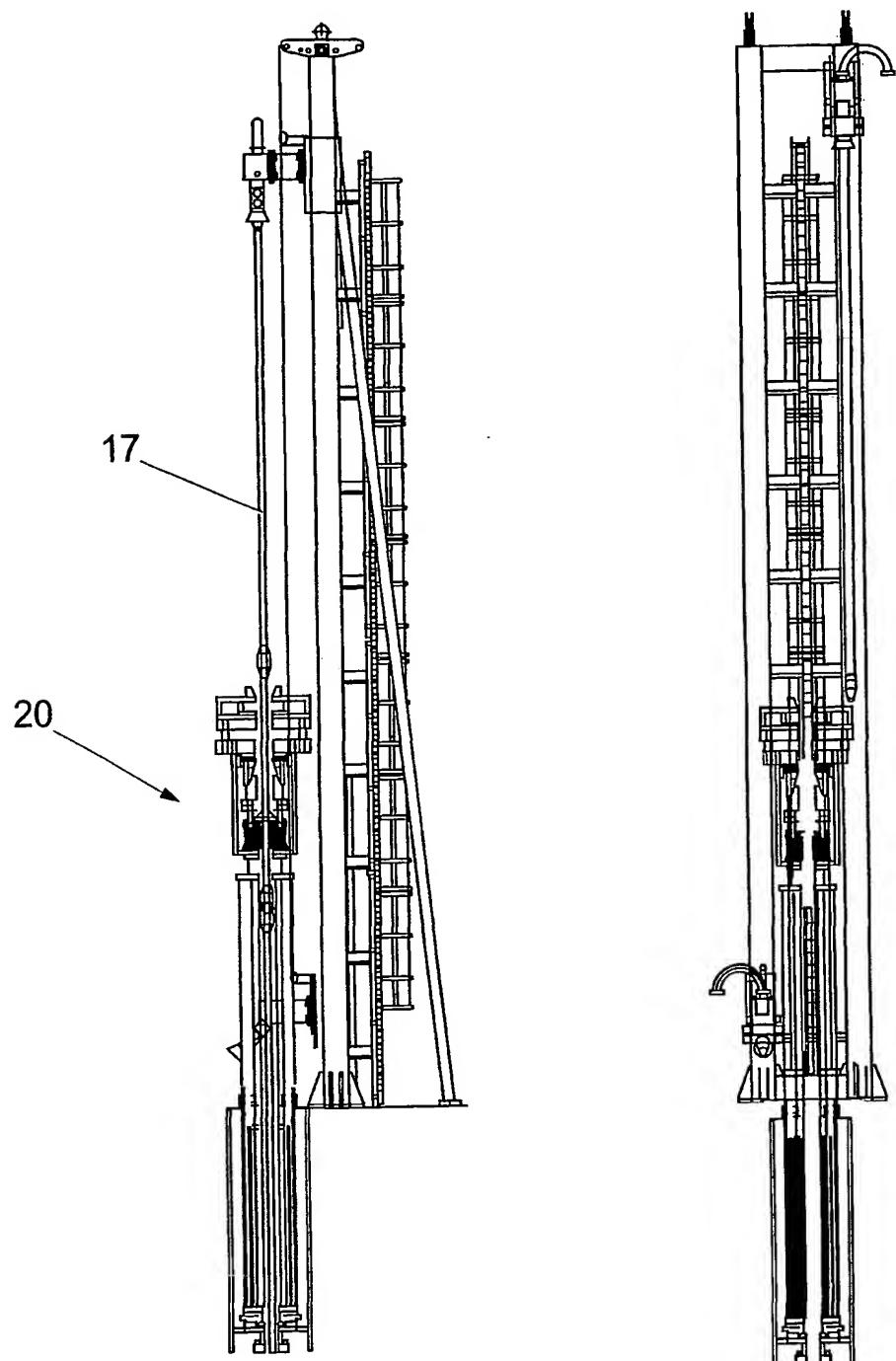


Fig. 13a

Fig. 13b

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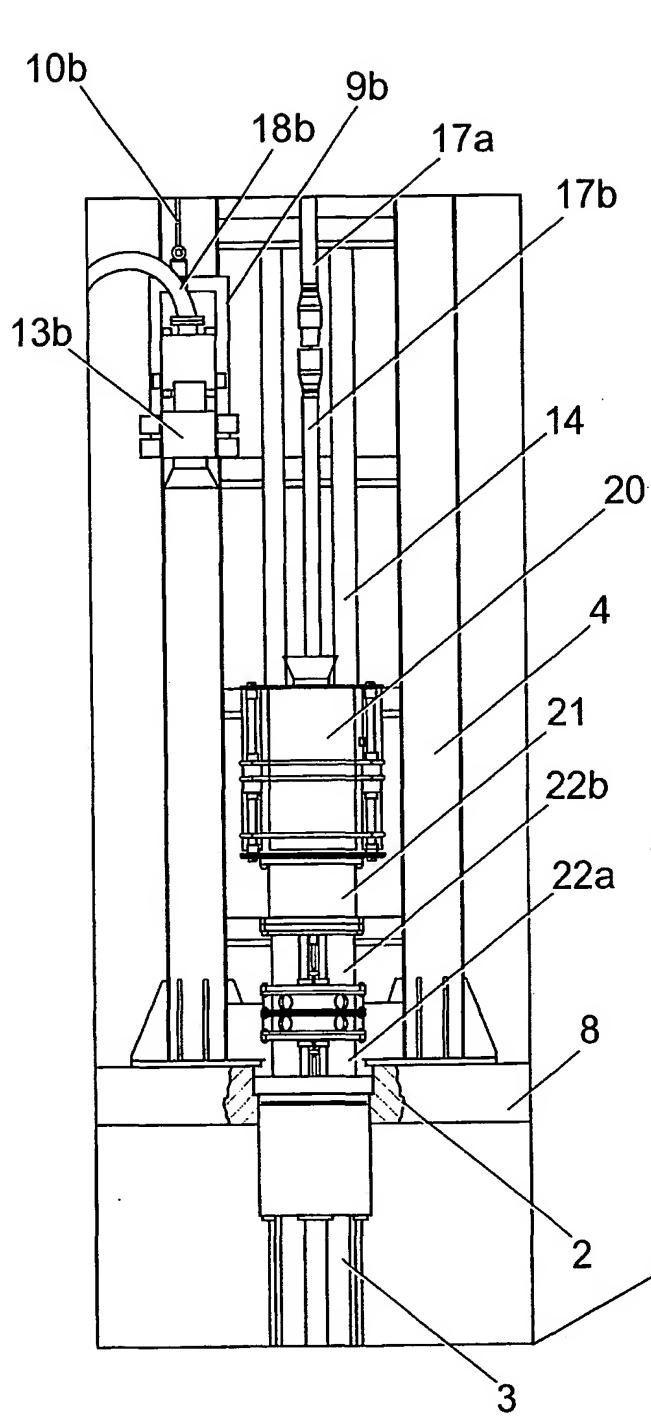


Fig. 14a

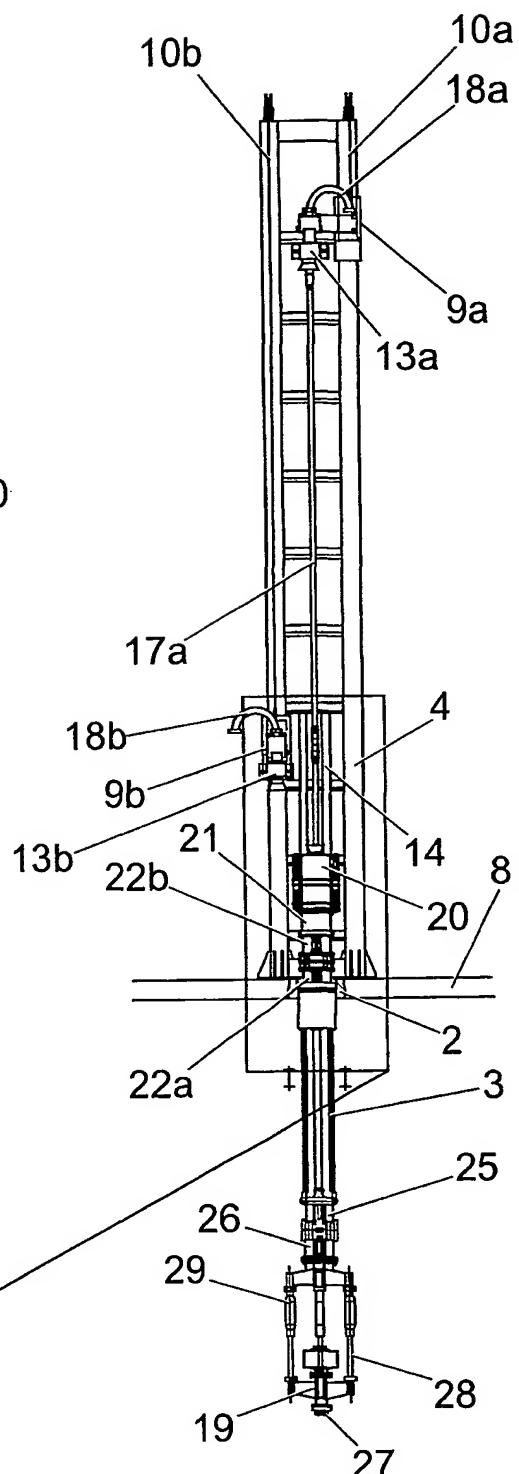


Fig. 14b

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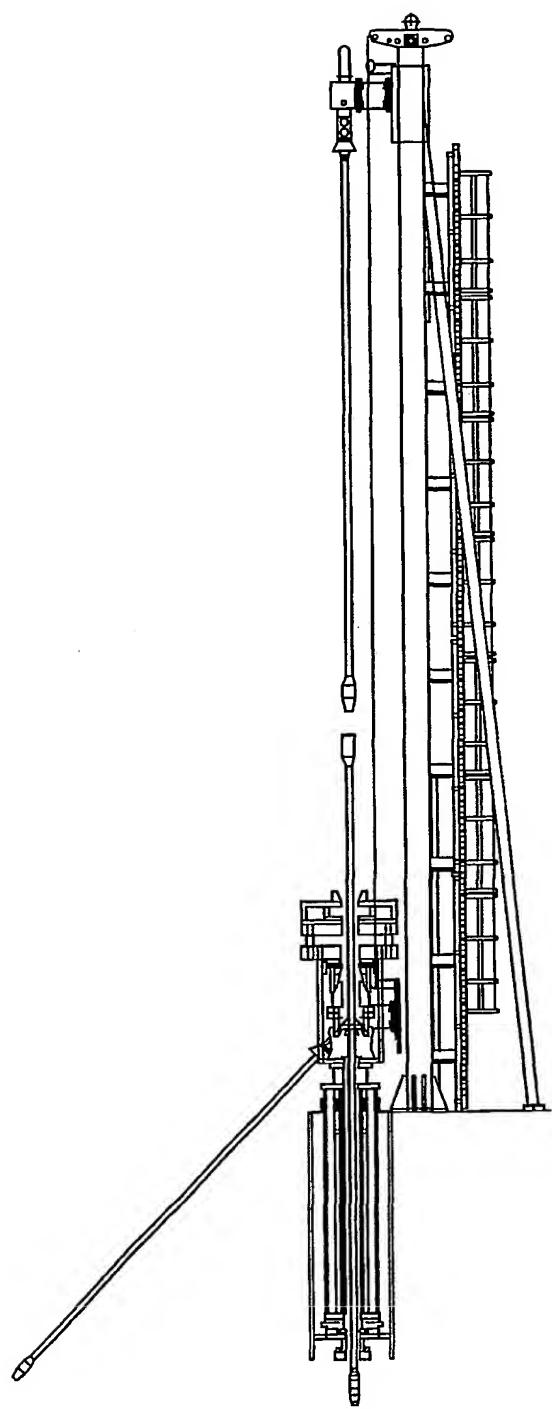


Fig. 15a

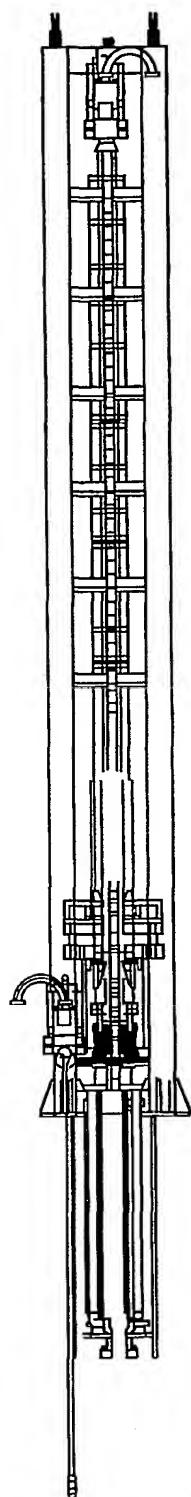


Fig. 15b

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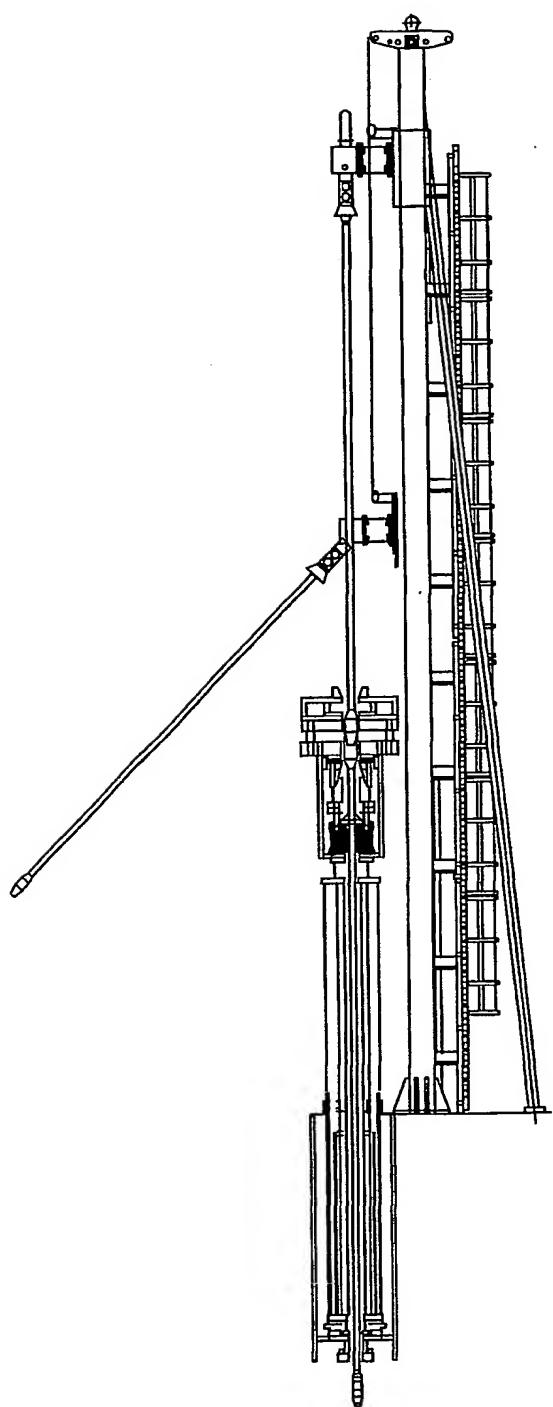


Fig. 16a

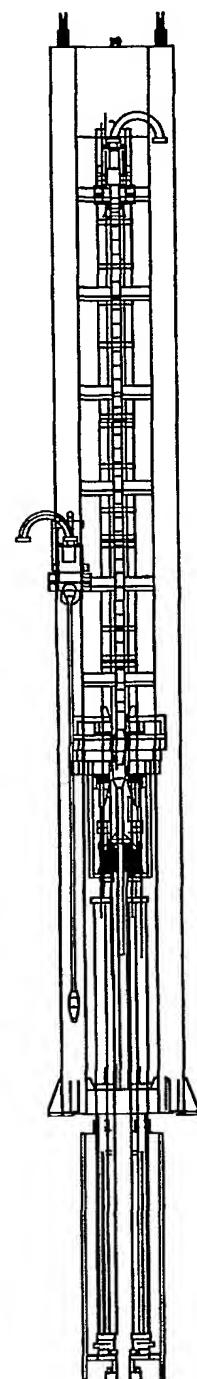


Fig. 16b

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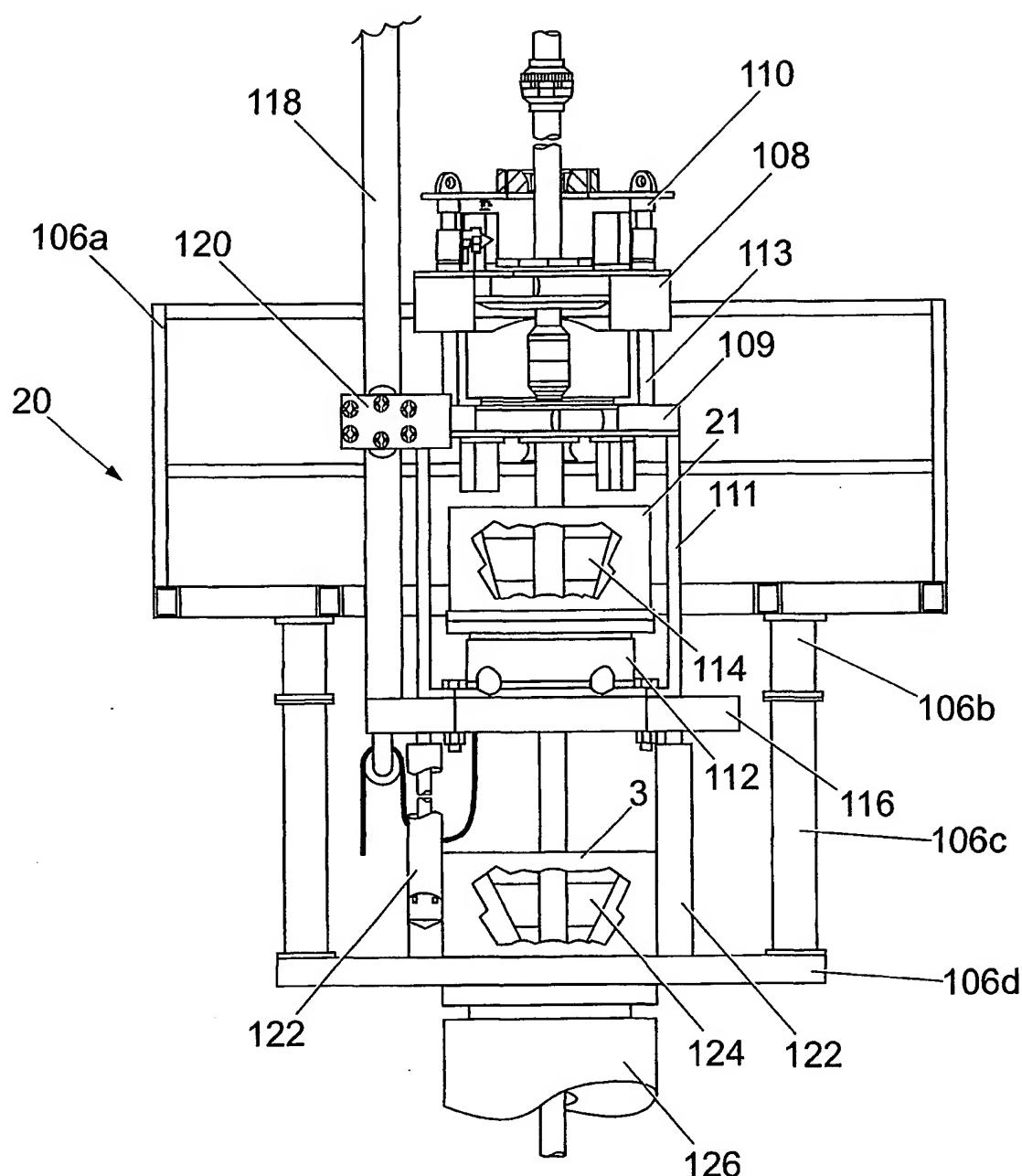


Fig. 17a

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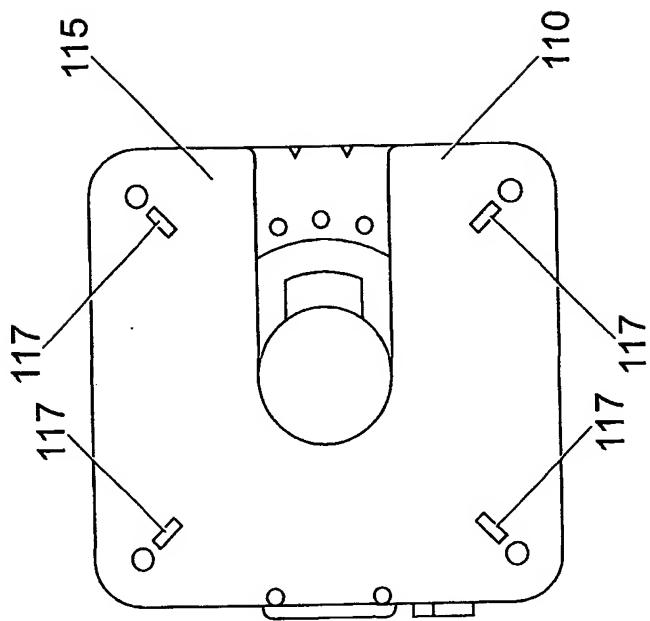


Fig. 17c

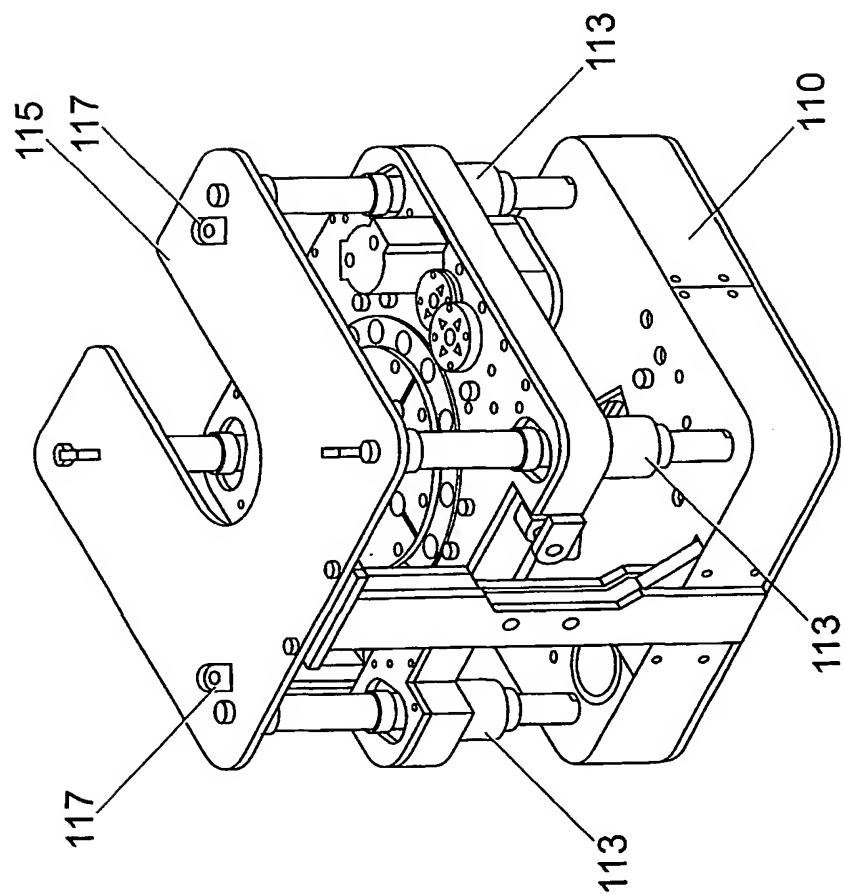


Fig. 17b

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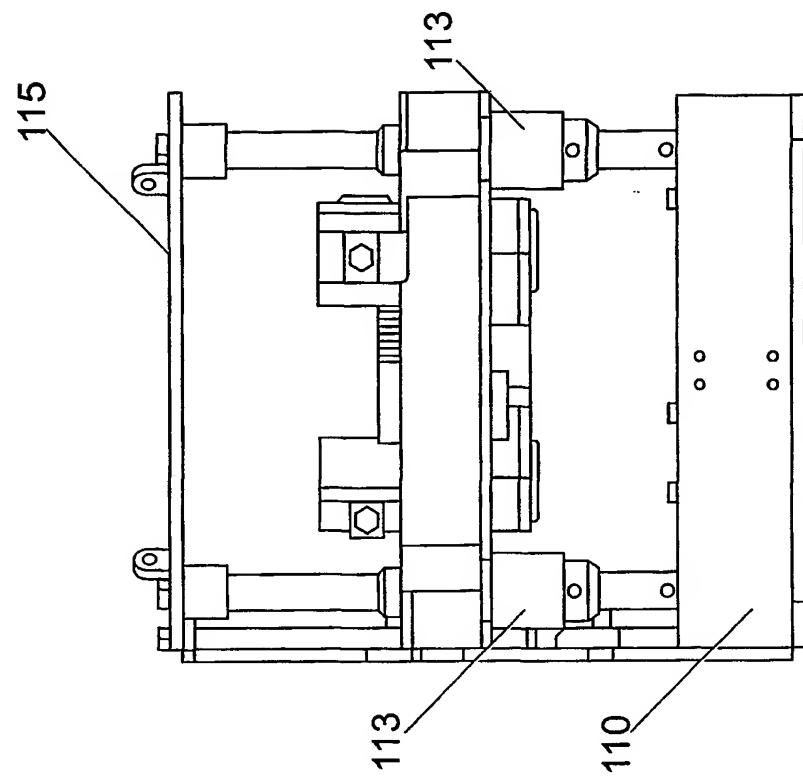


Fig. 17e

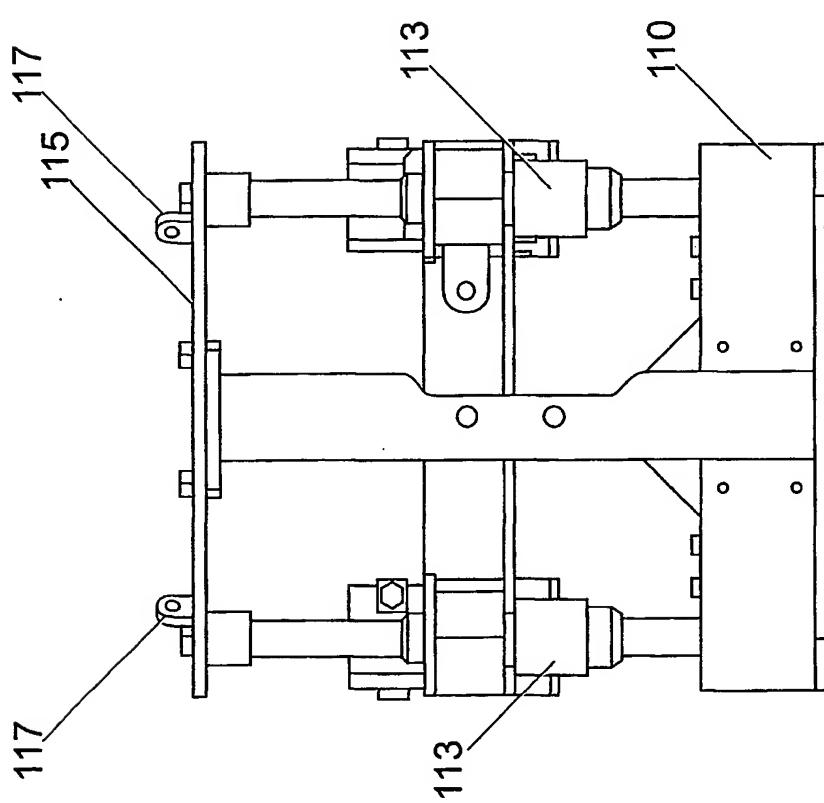


Fig. 17d

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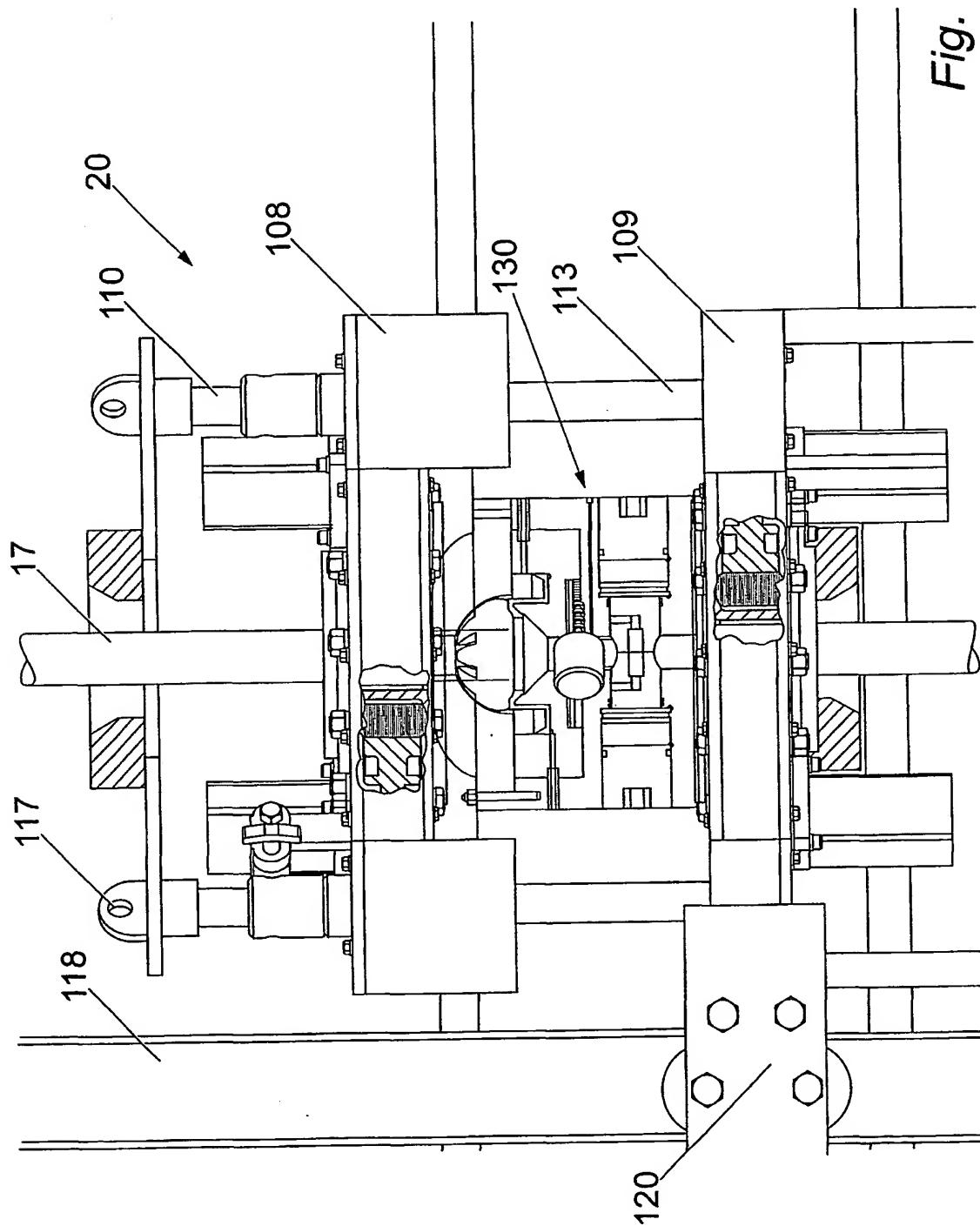


Fig. 18

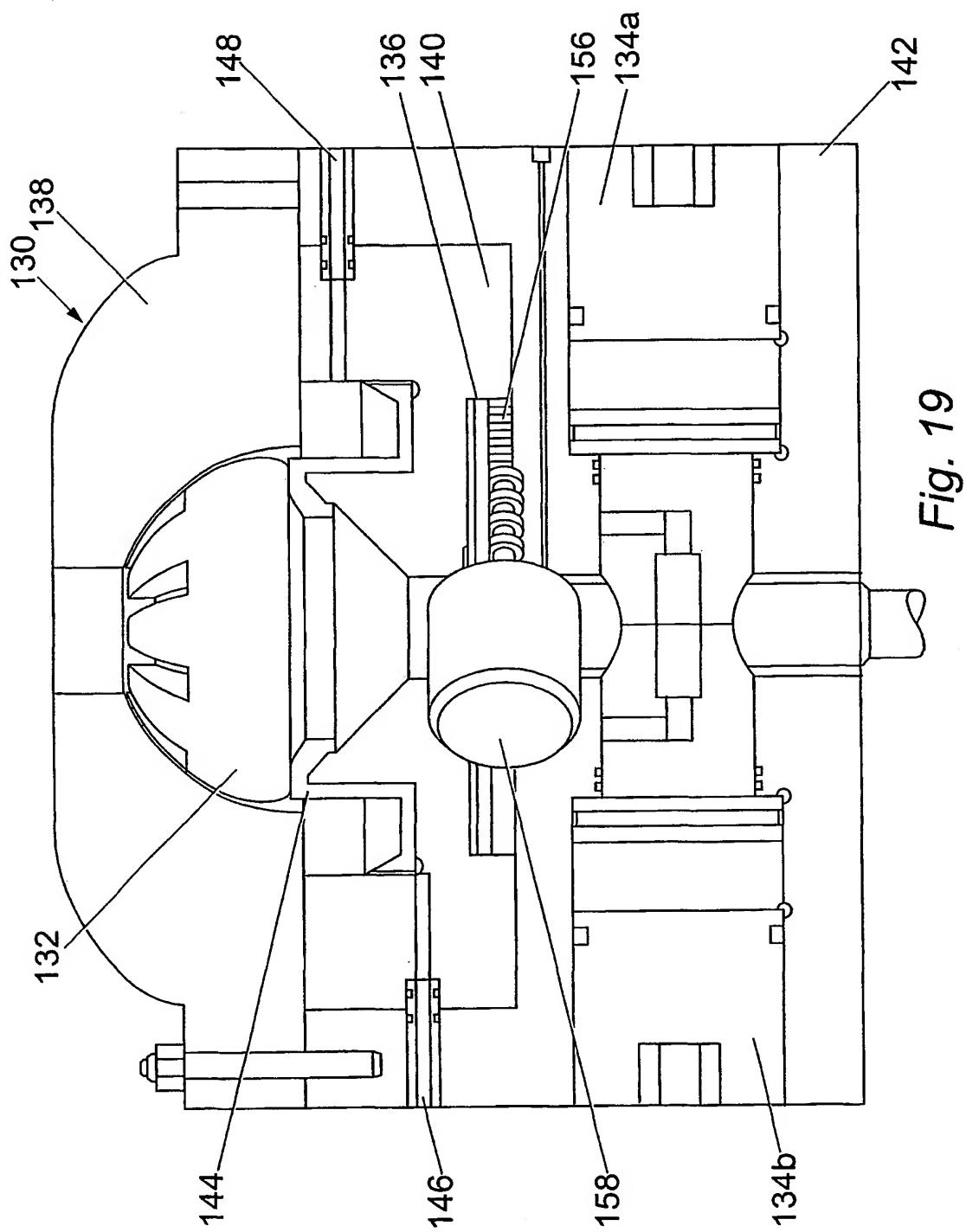
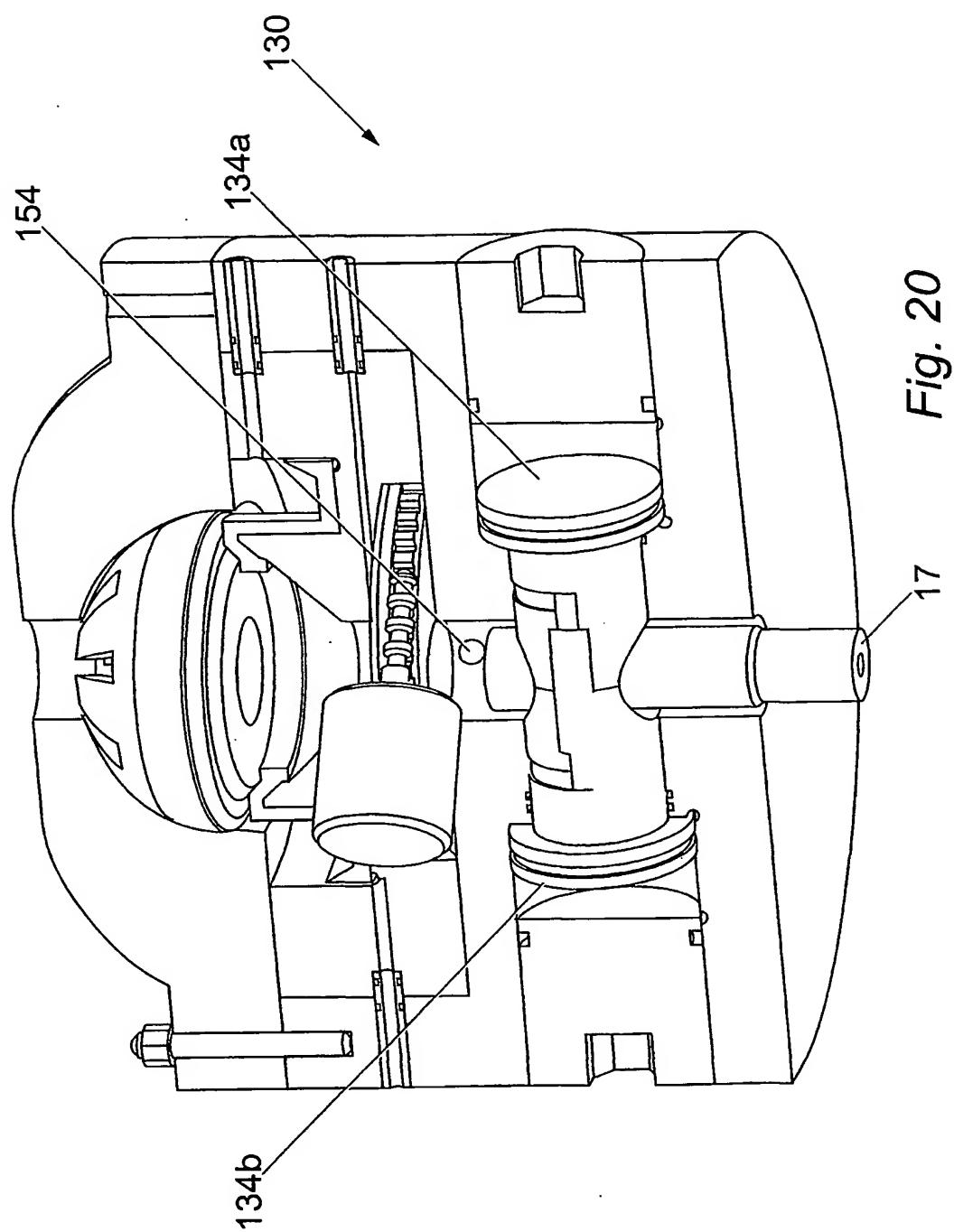


Fig. 19

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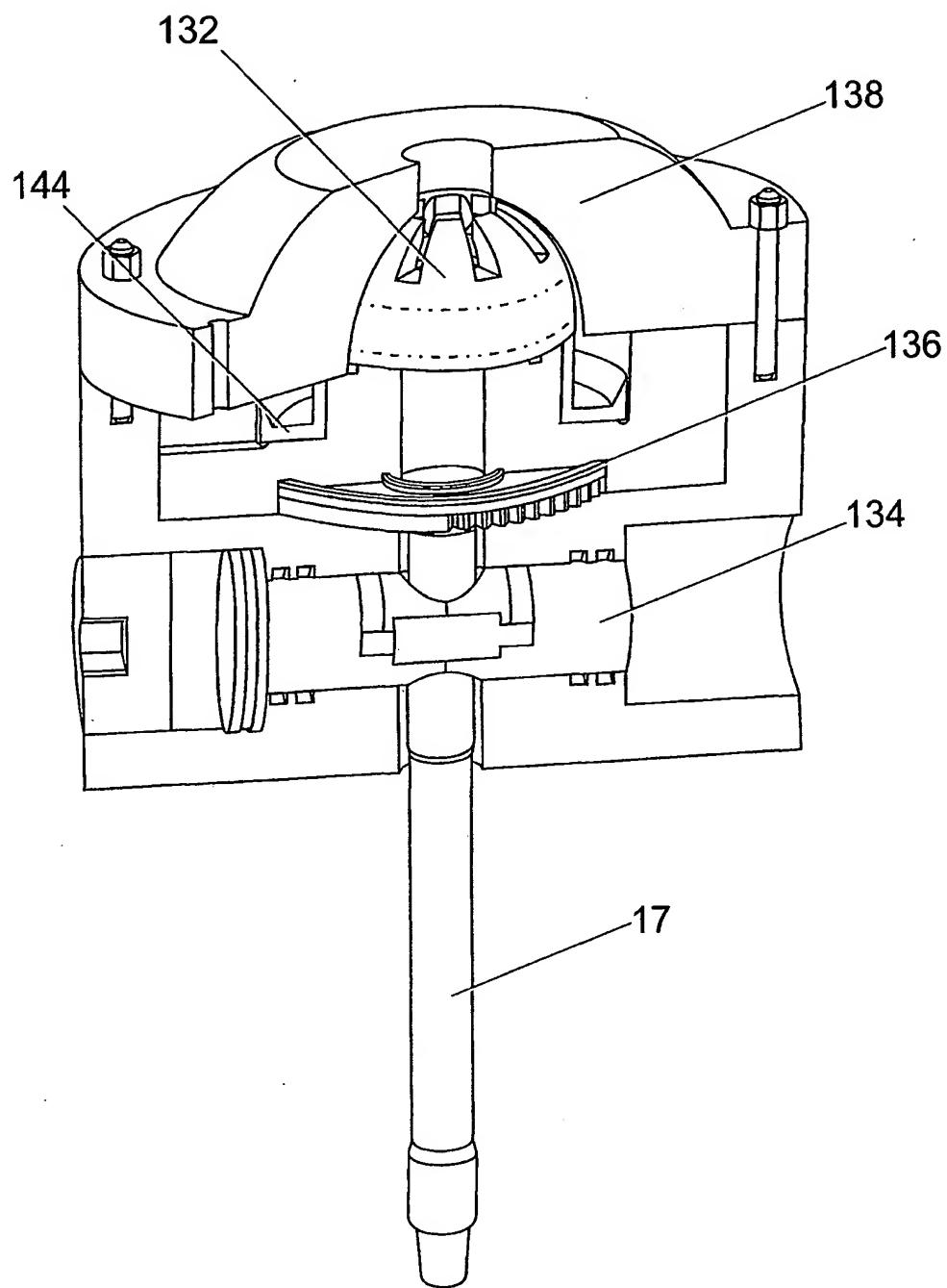


Fig. 21

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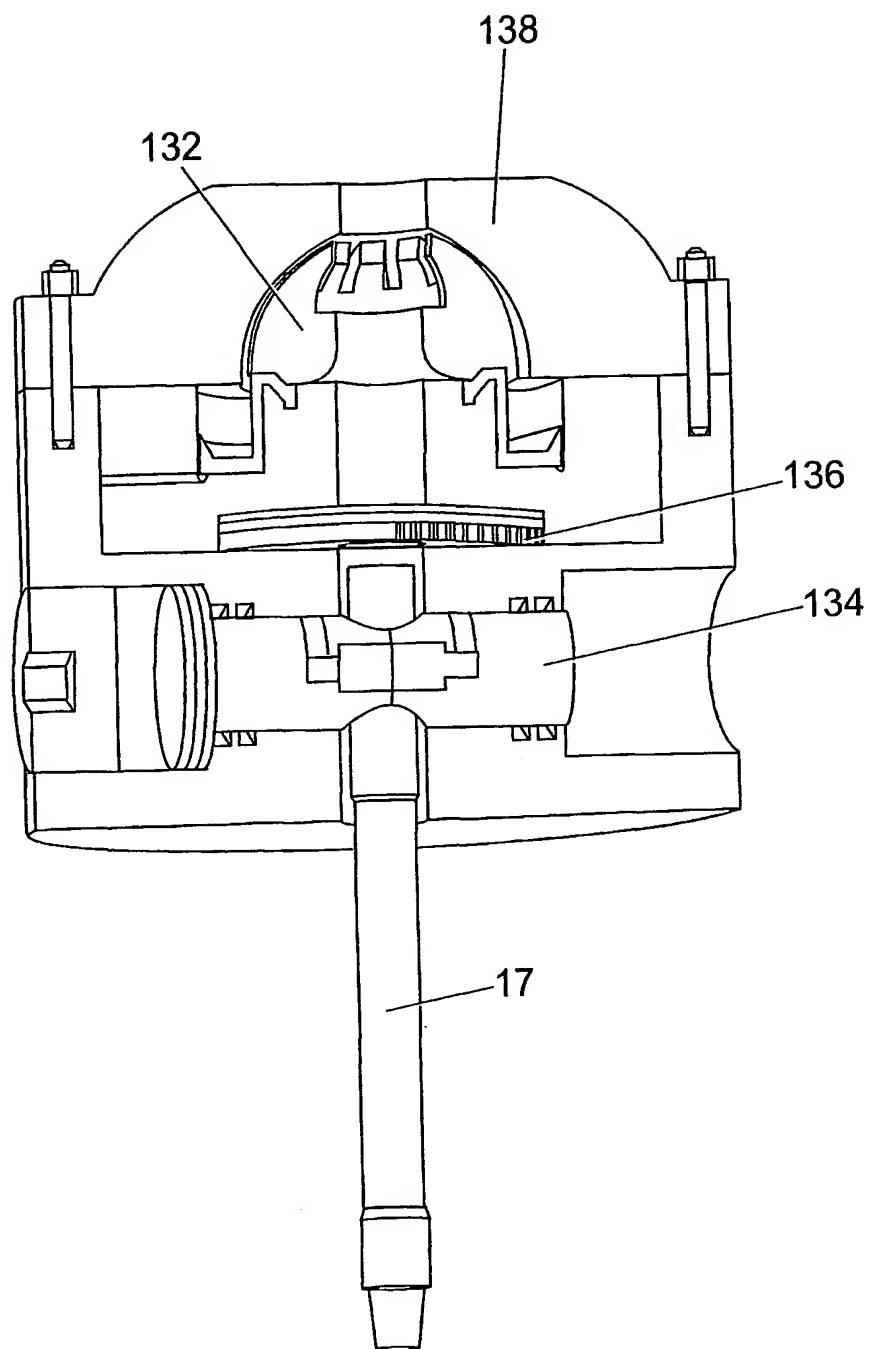


Fig. 22

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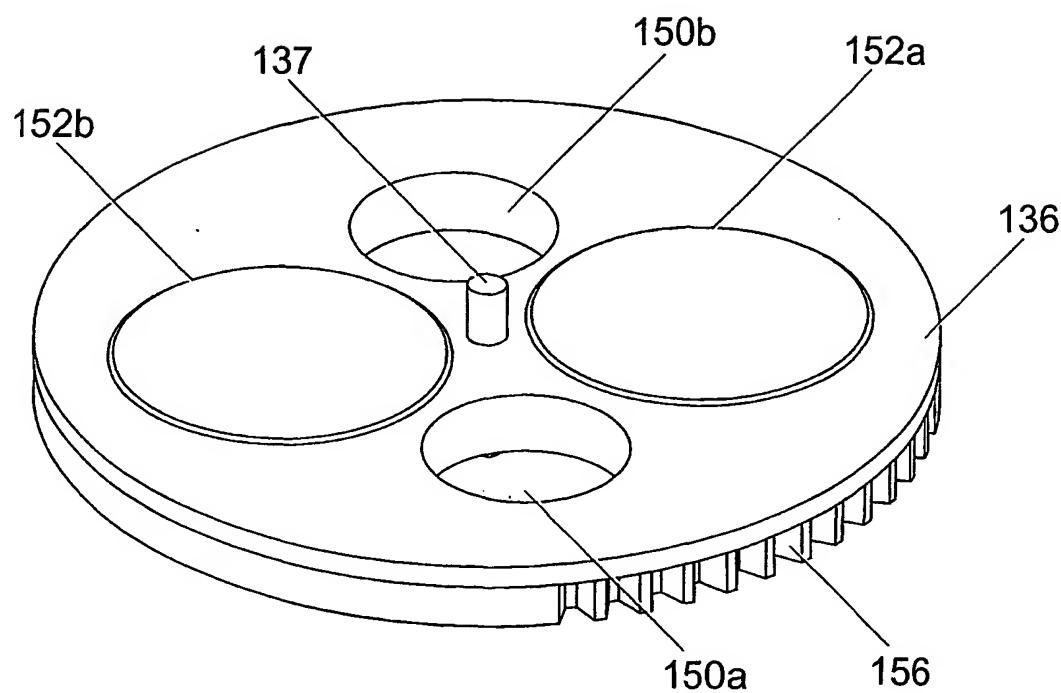


Fig. 23

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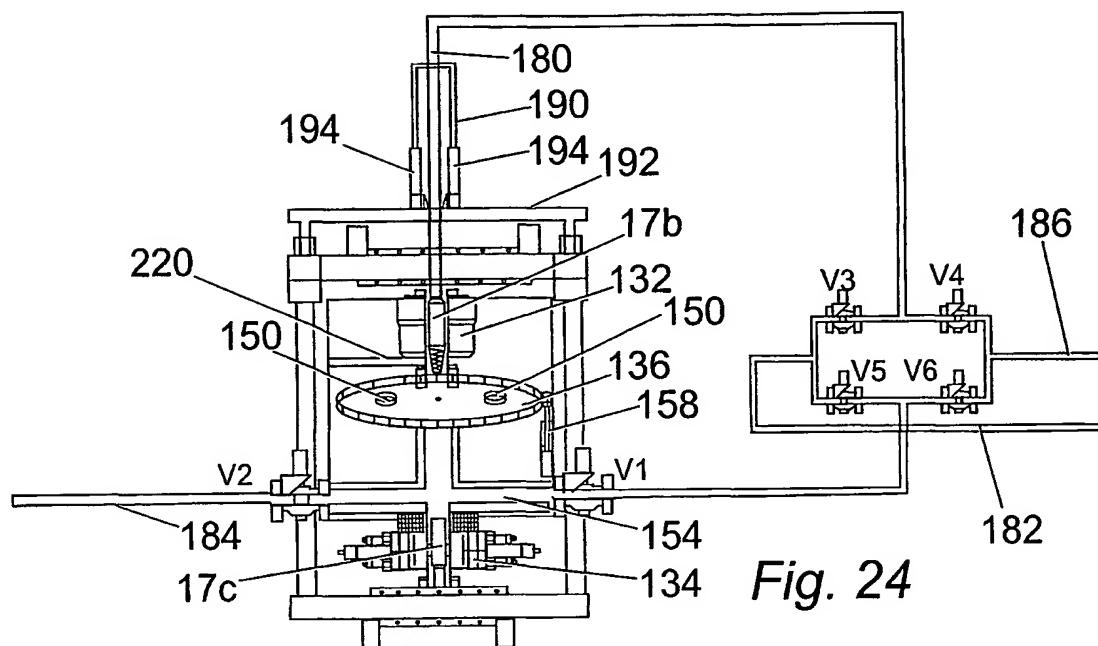


Fig. 24

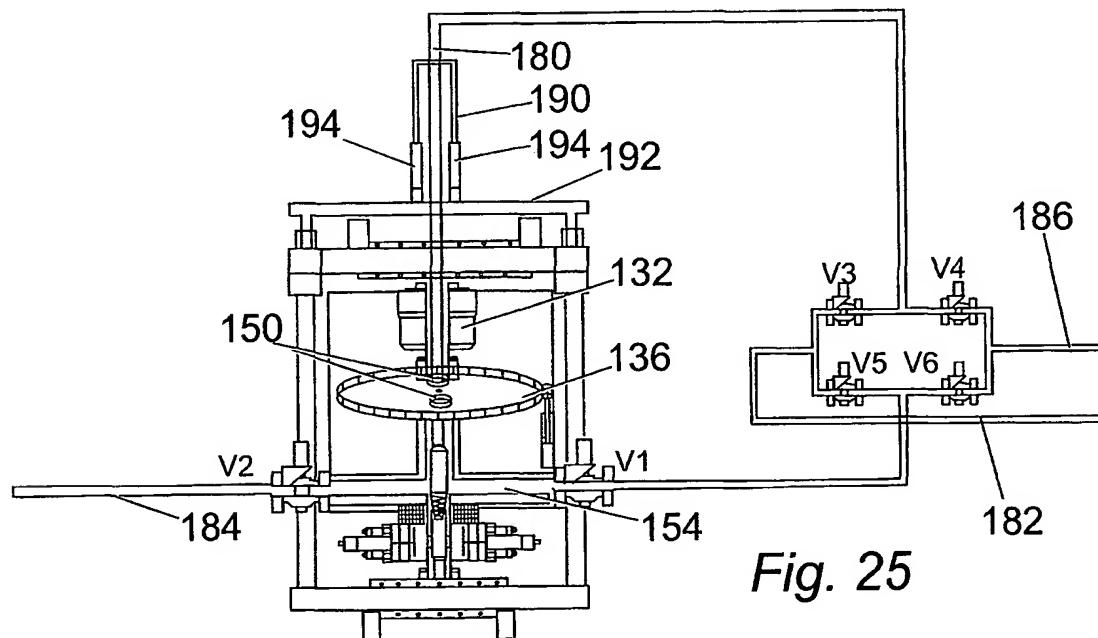


Fig. 25

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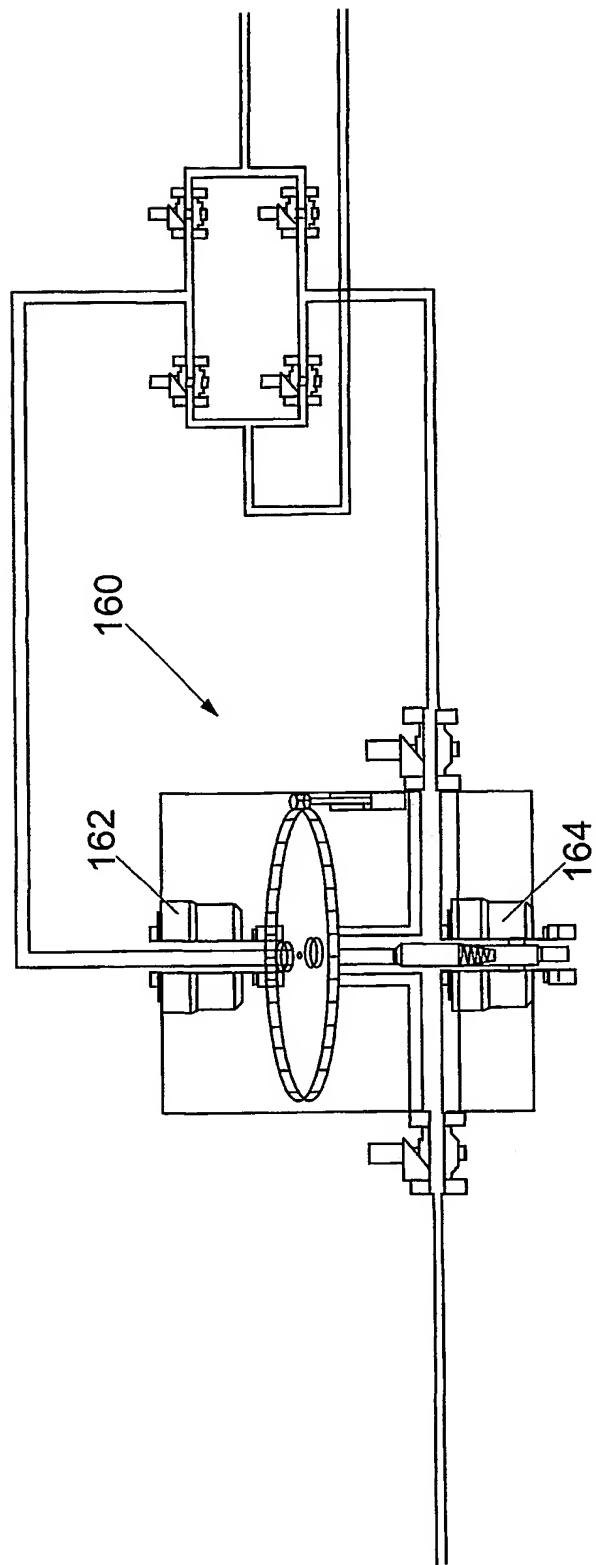


Fig. 26

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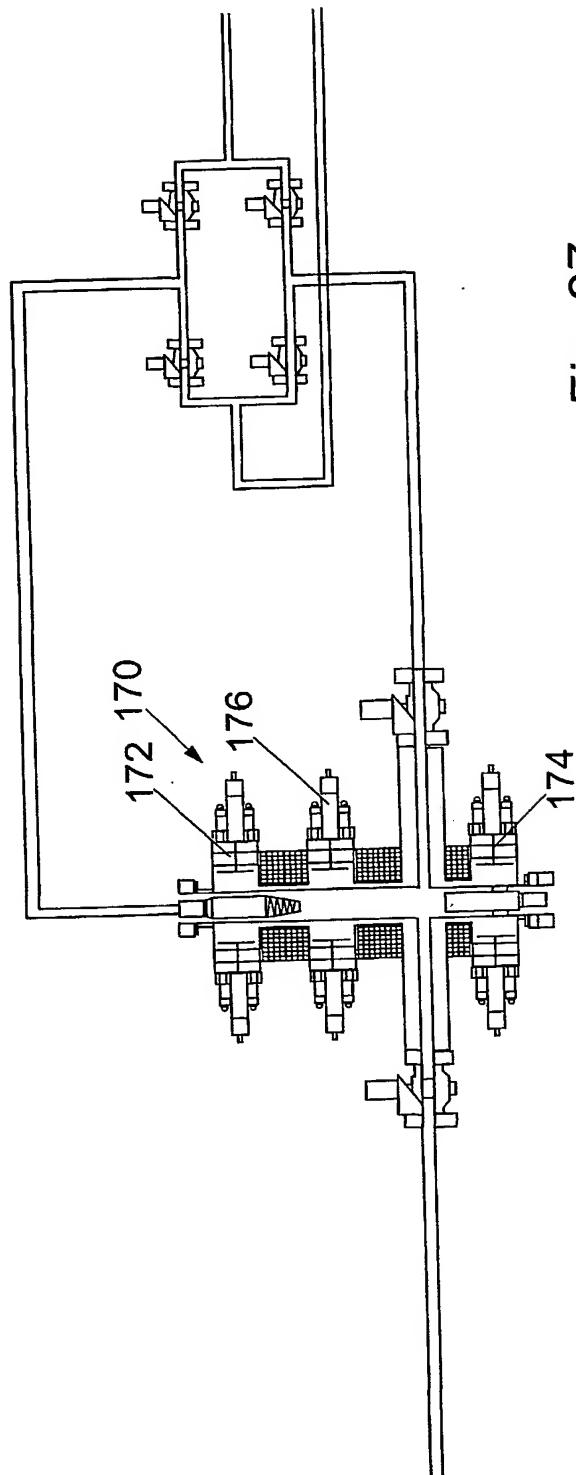


Fig. 27

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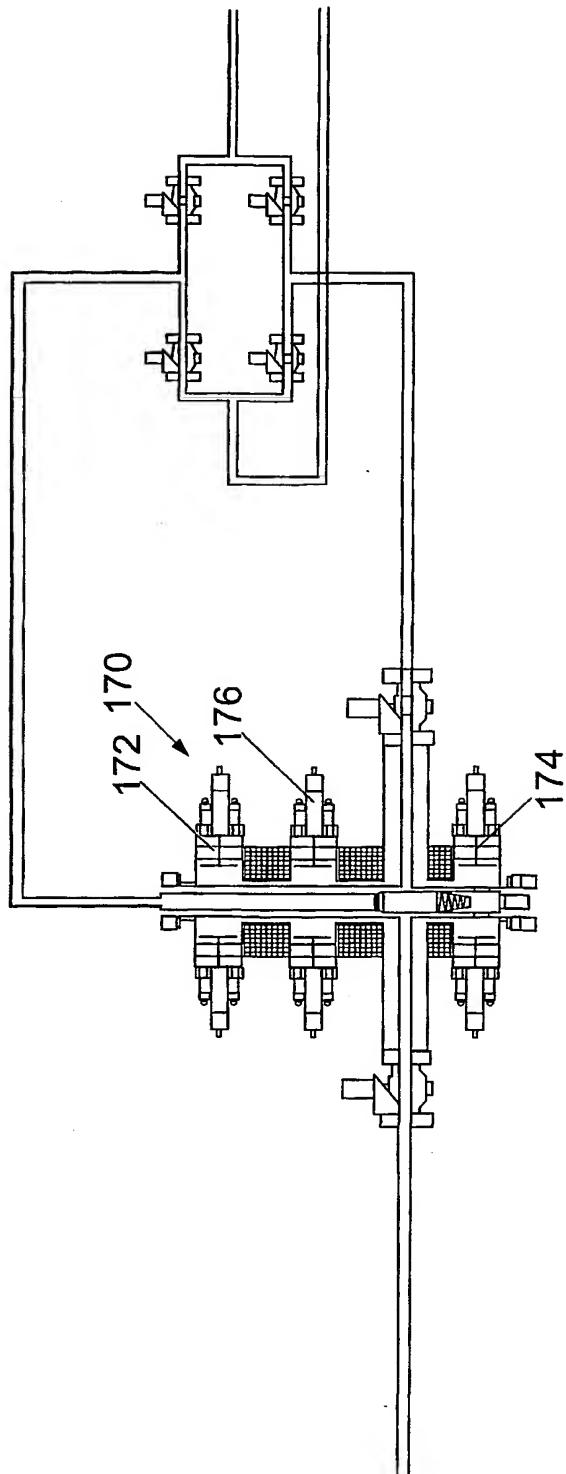
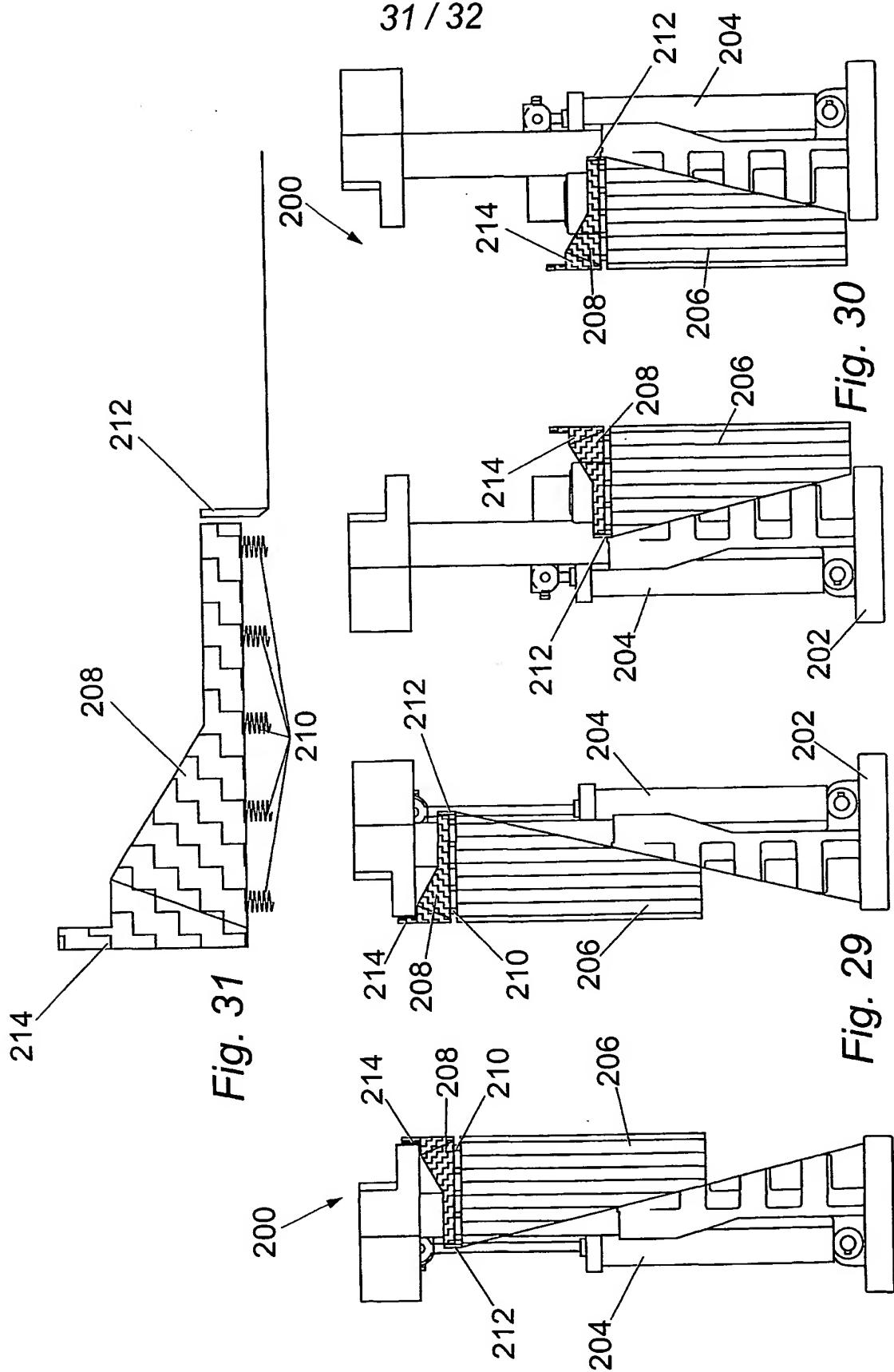


Fig. 27

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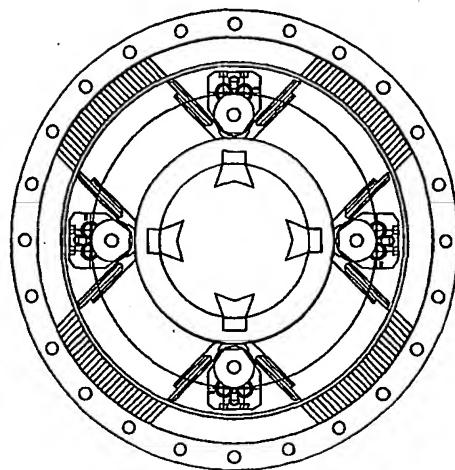


Fig. 34

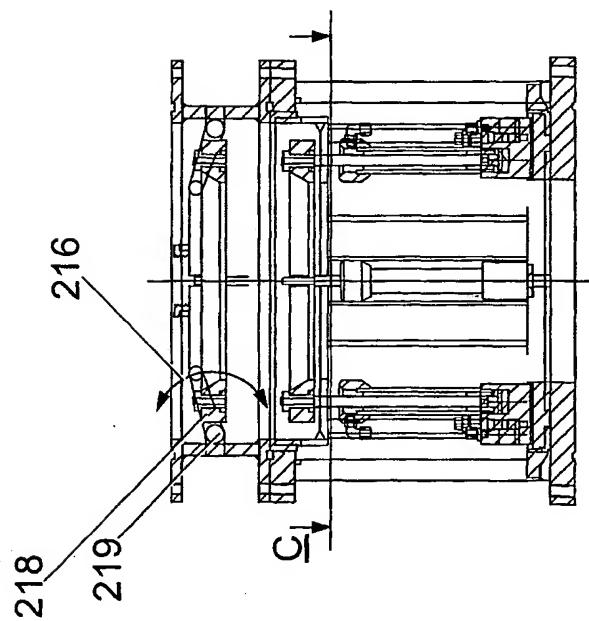


Fig. 33

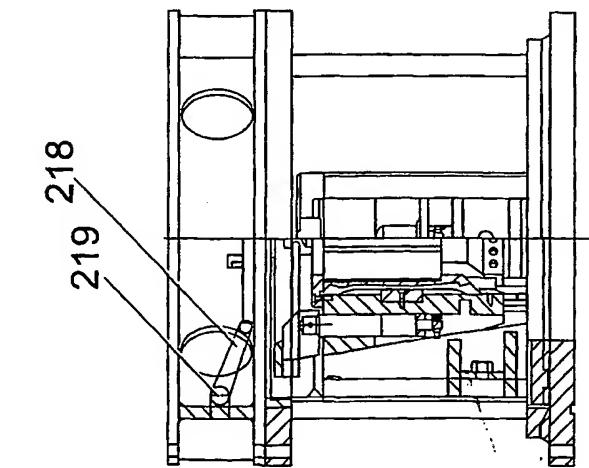


Fig. 32